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2180A
Digital Thermometer

Instruction Manual

P/N 489211
June 1978
REV. 2, 9/88

FLUKE

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

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2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

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All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way"* prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC, will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 2269, 5600 CG, Eindhoven, The Netherlands.

*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

Table of Contents

(Continued on Page ii)

TABLE OF CONTENTS, *continued*

List of Tables

* For 2180A curve fit Linearizations

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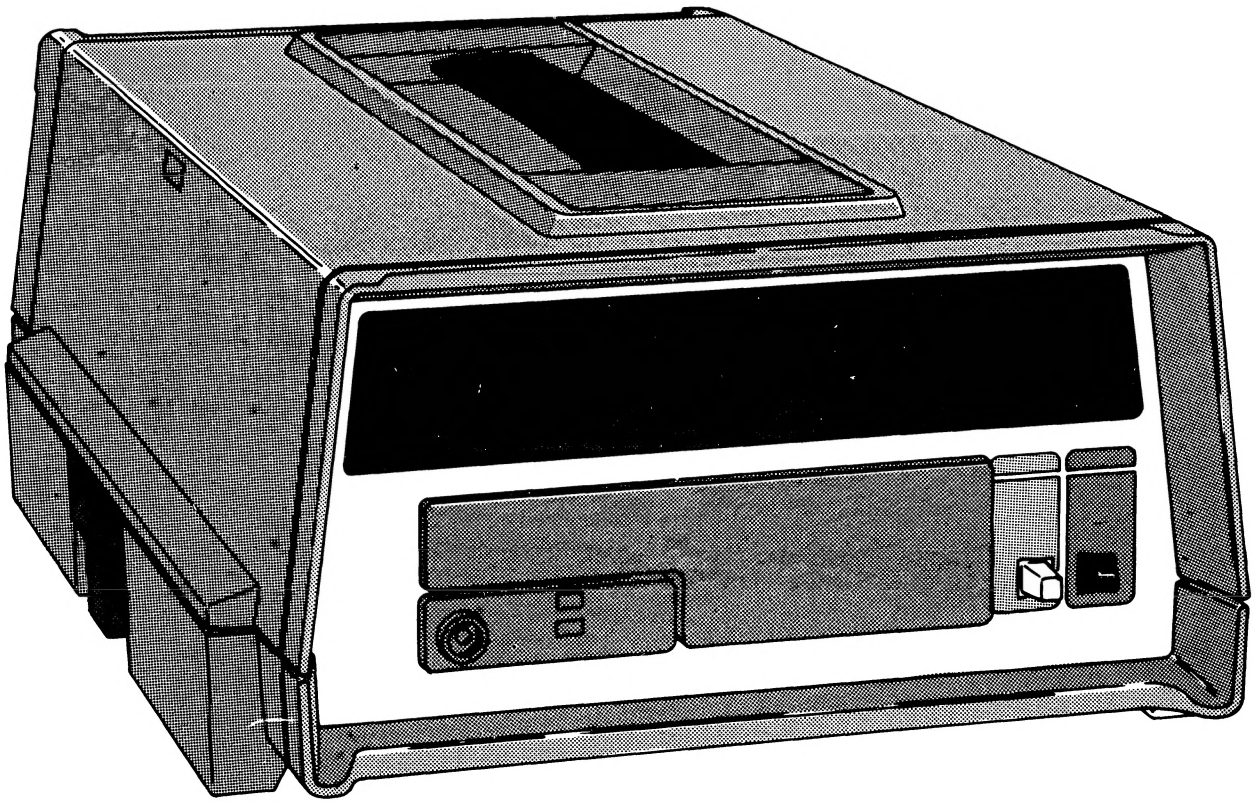
List of Illustrations



Model 2180A Digital Thermometer

Table 1-2. RTD Total Instrument Accuracy Specifications (cont)

RTD TYPE	RESOLUTION	TEMPERATURE RANGE APPLICABLE PORTION OF		MAXIMUM ERROR* +/-DEGREES C			+/-DEGREES F		
		°C	°F	AT CAL	90 DAYS 20° to 30°	1 YR. 15° to 35°	AT CAL	90 DAYS 68° to 86°	1 YR. 59° to 95°
100 ohm	.01°	-200 to 0 0 to 204	-327.9 to 32 32 to 399.2	.009 .009	.055 .098	.078 .139	.015 .015	.100 .177	.142 .252
390 Pt	.1°	-200 to 0 0 to 750	-327.9 to 32 32 to 1382.2	.08 .08	.10 .23	.11 .32	.13 .13	.16 .41	.19 .57
100 ohm	.01°	-200 to 0 0 to 204	-327.9 to 32 32 to 399.2	.040 .040	.086 .13	.109 .171	.071 .071	.156 .234	.198 .309
3916 Pt	.1°	-200 to 0 0 to 750	-327.9 to 32 32 to 1382.2	.11 .10	.12 .26	.14 .34	.17 .17	.21 .46	.24 .62
100 ohm	.01°	-200 to 0 0 to 204	-327.9 to 32 32 to 399.2	.008 .009	.055 .098	.078 .139	.014 .014	.099 .177	.141 .252
392 Pt	.1°	-200 to 0 0 to 750	-327.9 to 32 32 to 1382.2	.08 .08	.01 .23	.11 .32	.12 .12	.16 .41	.19 .57
100 ohm	.01°	-60 to 0 0 to 93	-76 to 32 32 to 199.4	.129 .129	.157 .176	.172 .199	.230 .231	.282 .317	.308 .359
617 Ni	.1°	-60 to 0 0 to 177	-76 to 32 32 to 350.6	.19 .19	.20 .22	.21 .25	.33 .33	.35 .39	.36 .44
10 ohm	.01°	N/A							
CU	.1°	-75 to 0 -75 to 150	-103 to 32 -103 to 302	.16 .16	.18 .20	.19 .23	.27 .27	.31 .35	.34 .41
ohms		0 to 196.99 0 to 999.99	.005 .05	.042 .22	.059 .31	ALL UNITS IN OHMS			

* Maximum error depends on the temperature measured and the resolution used. Of the four temperature ranges presentd for each RTD, the first two represent .01° resolution. The above maximum error numbers represent instrument errors only, and do not include the RTD probe.

Table 1-3. IPTS 68 Coefficients*

RTD TYPE	RTD LINEARIZATION COEFFICIENTS
100 OHM 385 Pt	DIN 43760 TABLE
100 OHM 390 Pt	ALPHA = 0.0038994 DELTA = 1.494 A4 = $-.0.265668^{10^{-4}}$ C4 = $-0.205984^{10^{-11}}$
100 OHM 3916 Pt	ALPHA = 0.003916 DELTA = 1.505 A4 = $-.099668^{10^{-5}}$ C4 = $-0.192912^{10^{-13}}$
100 OHM NI	ALPHA = 0.00617
10 OHM CU	RO = 9.042 OHM R25 = 10.005 OHM ALPHA = .004260
* SEE NBS MONOGRAPH 126	

Table 1-4. General Specifications

DIMENSIONS 10.49 cm H x 20.45 cm W x 32.64 cm D (4.13 in H x 8.05 in W x 12.85 in D)	**RELATIVE HUMIDITY** ≤80%, non-condensing, 0 to 50°C
WEIGHT 2.1 kg (4 lbs. 9 oz.)	**SHOCK AND VIBRATION** Meets MIL-T-28800 specifications
OPERATING POWER 12V dc or 100, 120, 220, 240V ac ±10%, selectable 50 to 400 Hz; 8W typical, 14W max.	**INPUT CONNECTION** 4-wire to screw terminal block
WARM-UP to RATED ACCURACY 5 minutes	**INPUT IMPEDANCE** 1000 Mohms at DC
STORAGE TEMPERATURE –40°C to +75°C (Y2009 and Option 21X0A-004: 0 to 40°C)	**STABILITY** ±175 ppm in 90 days, ±200 ppm per year

Table 1-4. General Specifications (cont)

OPERATING TEMPERATURE
0 to 50°C
(Y2009: 0 to 40°C)

ACCURACY vs WIRE LENGTH
No lead resistance error 4-wire RTD's if R_2 adjustment on the RTD Input Module is used. Otherwise, 0.04°C/Ω resistance of any one input lead if R_2 is not adjusted.

DISPLAY
°F or °C, switch-selectable, 7-segment LEDs 1.1 cm high

RESOLUTION
0.01° below 204°C for platinum RTD's, automatically shifting to 0.1° above 204°C (93°C for nickel RTD's). If readings are decreasing, shift is at 77°C for platinum, 66°C for nickel.

MEASUREMENT METHOD
Dual slope integration, under microcomputer control. 100 ms integration period, three readings per second. A/D Resolution is 100,000 counts at full-scale.

LINEARIZATION TECHNIQUES
Computer algorithm, 4th order curve fit.

COMMON MODE REJECTION
≥160 dB at DC, 50, 60, and 400 Hz ±0.1% with 100Ω unbalance at inputs.

SAFETY
Protection Class 1
Relates solely to insulation or grounding properties defined in IEC 348.

TEMPERATURE COEFFICIENT
±15 ppm/°C from 25°C

RTD EXCITATION CURRENT
Nominal 0.5 mA.

COMMON MODE VOLTAGE
350V dc, 250V ac rms max.

NORMAL MODE REJECTION
≥90 dB at DC, 50, 60, and 400 Hz ±0.1%.

RESPONSE TIME
1 second typical.

ZERO DRIFT
Automatic zero correction.

RTD TYPES
100Ω 385 Pt (DIN), 390 Pt, 3916 Pt, 392 Pt, 100Ω Ni (DIN), 10Ω CU.

VOLTAGE RANGE (CALIBRATION ONLY)
No annunciator or decimal point.
99999 μV full scale (switch S2 in AUTO), resolution 1 μV
999990 μV full scale (switch S2 in .1), resolution 10 μV

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Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 2180A Digital Thermometer is a portable, five digit RTD thermometer. Temperature measurements are possible, depending on RTD type employed, over a range of -219°C to +664°C (-394°F to +1435°F) with 0.1° or .01° resolution. The instrument features:

1. Front Panel switch selection of Fahrenheit or Celsius readings.

2. Switch selectable RTD inputs.

3. Switch selectable input line voltage.

4. Dual slope measurement techniques.

5. Digital linearization of the RTD inputs.

1-3. DESCRIPTION

1-4. The instrument display features seven, high-intensity, seven segment LEDs, and leading zero suppression. Six of the LEDs are used to display numeric data, with a minus sign for negative temperature readings. The remaining LED displays the selected temperature scale character (°F or °C).

1-5. A four connection, screw-type terminal block is provided on the removable Input PCB for RTD connections. Input switch settings on this module will determine the microcomputer program necessary to linearize the desired RTD's input. A precision, four-wire resistance measurement of the RTD is routed through this module to the thermometer's input circuitry.

1-6. Selection of the temperature scale for display is made with a front panel pushbutton. The scale selected, Celsius or Fahrenheit, is displayed as the last character in the temperature reading (°C or °F). A scale change can be made at any time, and has no effect on calibration of the instrument.

1-7. Options and accessories available for the 2180A are listed in Table 1-1. More information concerning these items is given in Section 6 of this manual, Option and Accessory Information.

1-8. The measurement range of the 2180A Digital Thermometer is determined by the type of RTD used as the input device. RTD Types and total instrument accuracy specifications are listed in Table 1-2. Linearization of the RTD input is accomplished through toggling of the input switch segments on the RTD Input Module. Switch positions, numbers and applications are printed on the removable module beside the switch.

1-9. Four input line voltages are available for switch selection. Selection may be made for 100, 120, 220, or 240 volts ±10% as required to meet local conditions. Frequency may vary between 50 and 440 Hertz for all voltage selections. Refer to Section 4 of this manual when changing the selected input line voltage. Refer to Section 2, "Input Power" for 12 volt dc operation.

1-10. SPECIFICATIONS

1-11. Specifications for the 2180A Digital Thermometer are given in Table 1-4. These specifications assume that microcomputer type #2 has been installed in your instrument and at power-up the display reads "8002.2"

Table 1-1. 2180A Options and Accessories

ACCESSORY	DESCRIPTION
Y2000	Multipoint Selector, RTD
Y2009	Battery Pack, 12V Rechargeable
Y2010	Rack Panel PTI, single, A size (for Y2000)
Y2014	Rack Panel PTI, single, C size (for 2180A and Y2002)
Y2015	Rack Panel PTI, double, C size (for 2180A and Y2002)
Y2016	7-inch Rack Adapter PTI, single, D size
Y2017	7-inch Rack Adapter PTI, double, D size
Y2020	Panel Mount PTI-DIN, C size (for 2180A and Y2002)
Y2021	145 mm Panel Mount PTI, D size
Y2022	Divider, Thermometer Calibrator
Y2024	Power Cord, 3-way
Y2026B	Cable, Output Unit, RS-232-C
Y2031	Input Module (for 2180A)
Y2035	Thermal Paper (box of 10)
Y2037	Pt 390 RTD Probe
Y2039	Pt 392 Probe

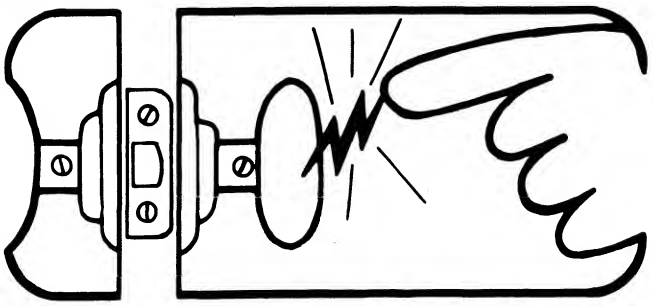
Table 1-2. RTD Total Instrument Accuracy Specifications

RTD TYPE	RESOLUTION	TEMPERATURE RANGE APPLICABLE PORTION OF		MAXIMUM ERROR* +/-DEGREES C			+/-DEGREES F		
		°C	°F	AT CAL	90 DAYS 20° to 30°	1 YR. 15° to 35°	AT CAL	90 DAYS 68° to 86°	1 YR. 59° to 95°
100 ohm	.01°	-190 to 0	-309.9 to 32	.043	.089	.112	.076	.161	.203
		0 to 204	32 to 399.2	.043	.132	.173	.076	.239	.314
385 Pt	.1°	-190 to 0	-309.9 to 32	.11	.12	.14	.18	.21	.24
		0 to 750	32 to 1382.0	.11	.26	.37	.18	.46	.62

static awareness

A Message From

John Fluke Mfg. Co., Inc.

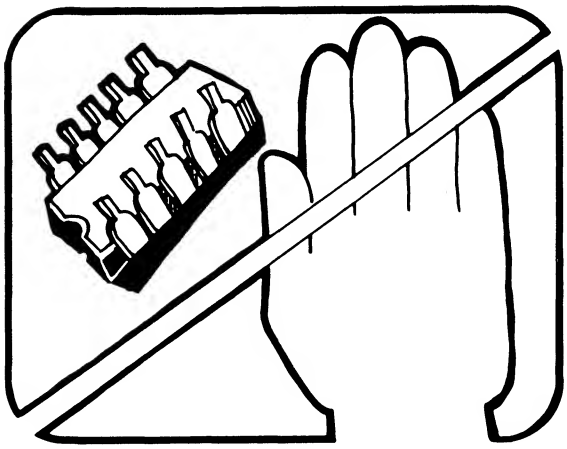


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

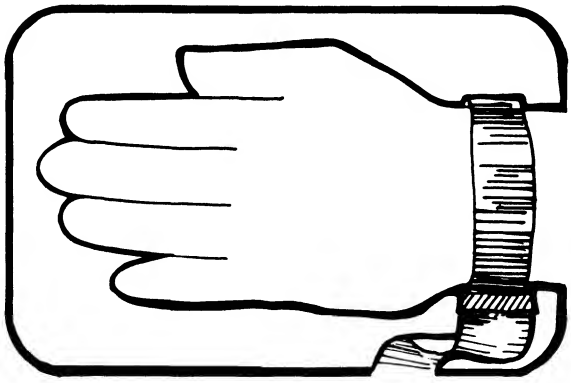
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗"

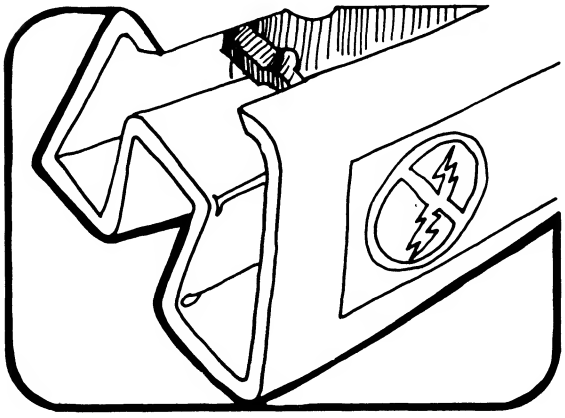
The following practices should be followed to minimize damage to S.S. devices.



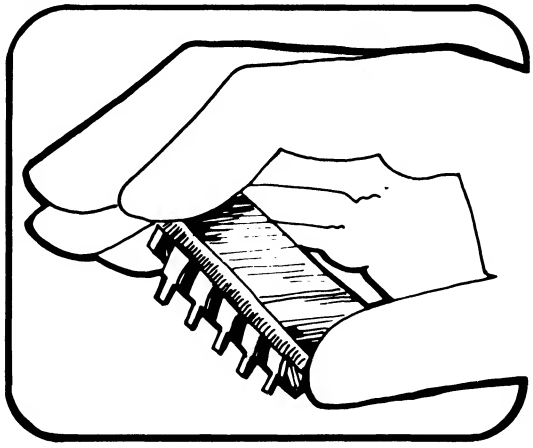
1. MINIMIZE HANDLING



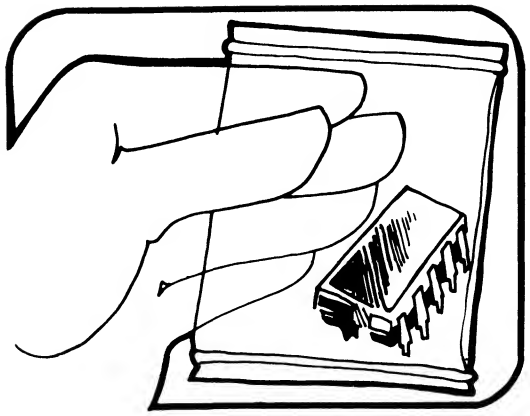
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



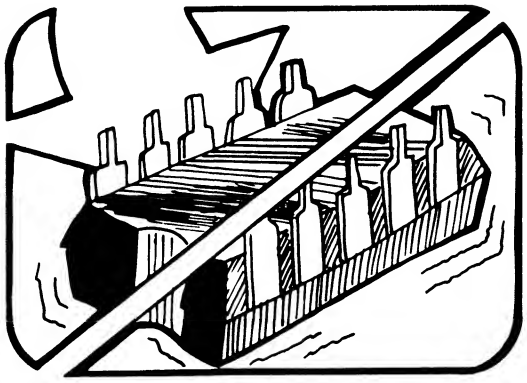
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



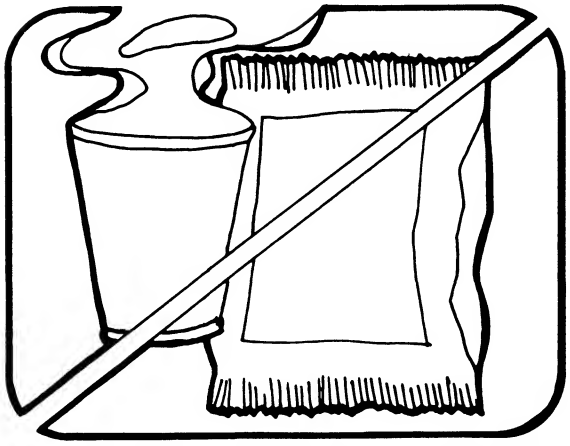
4. HANDLE S.S. DEVICES BY THE BODY



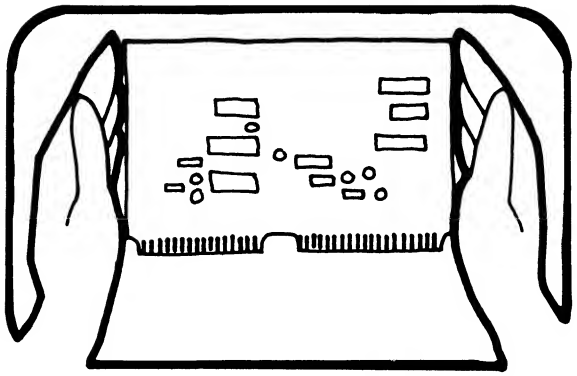
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT



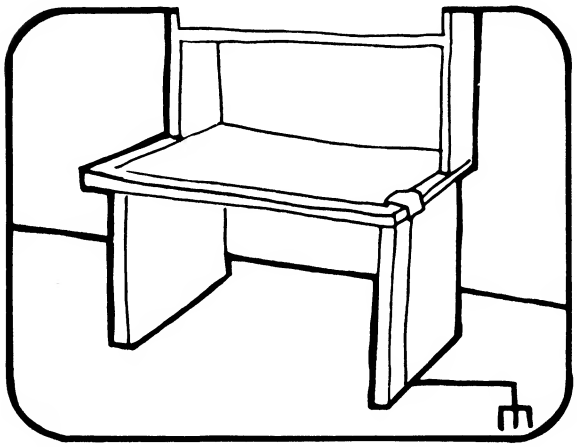
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS TO PROTECT INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

A complete line of static shielding bags and accessories is available from Fluke Parts Department, Telephone 800-526-4731 or write to:

JOHN FLUKE MFG. CO., INC.
PARTS DEPT. M/S 86
9028 EVERGREEN WAY
EVERETT, WA 98204

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Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding installation and operation of the 2180A Digital Thermometer. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, please contact your nearest Fluke Technical Service Center, or John Fluke Mfg. Co., Inc. P.O. Box C9090, Everett, WA 98206, Tel(206) 356-5400. A list of Technical Service Centers is located in Section 7 of this manual.

2-3. SHIPPING INFORMATION

2-4. The 2180A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included on the shipping carton.

2-5. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The 2180A will operate at any of four switch selected input line voltages, all of which operate at frequencies from 50 to 440 Hertz. Before connecting the 2180A to the local ac line, verify that the present setting of the instrument matches the local line voltage. A decal on the instrument rear panel defines the original setting required for operation. Refer to Section 4 of this manual for instructions on verifying or changing the input line voltage switch settings.

2-8. The rear panel ac input connector is a three-prong, U-ground connector which permits the instrument to be connected, via the power cord, to the applicable line voltage. The offset prong on this connector is attached to the 2180A power supply, and should be connected through the power cord to a high quality earth ground.

2-9. The 2180A will also operate on 12V dc power. A rear panel terminal block, with screw tightened connections, (TB1), allows for ease of attachment. Actual input voltage may vary from 11 to 15V dc; most 12V dc power supplies capable of supplying 1A (e.g., a car battery) can be utilized.

2-10. INSTALLATION

2-11. The 2180A is contained in a special molded plastic instrument case. Other associated accessories used with the 2180A will be packaged in similar PTI (Portable Test Instrument) cases varying only in size. The cases are, in all other respects, compatible and can be stacked vertically and latched together to form miniature portable test systems. Instrument stacks should be limited to a total of 40 pounds.

2-12. Use the following procedure when attaching PTI cases to each other:

1. For the top case, pull out latches found on either side of the instrument.

2. Nestle top and bottom cases together.

3. Push latches in to secure units together.

2-13. Prepare the 2180A for operation by plugging the input line power cord into the applicable power source or connecting the external input connector to an external 12V dc source.

2-14. OPERATING FEATURES

2-15. The location of the 2180A controls, indicators, and connectors is shown and described in Figure 2-1 and Table 2-1 respectively.

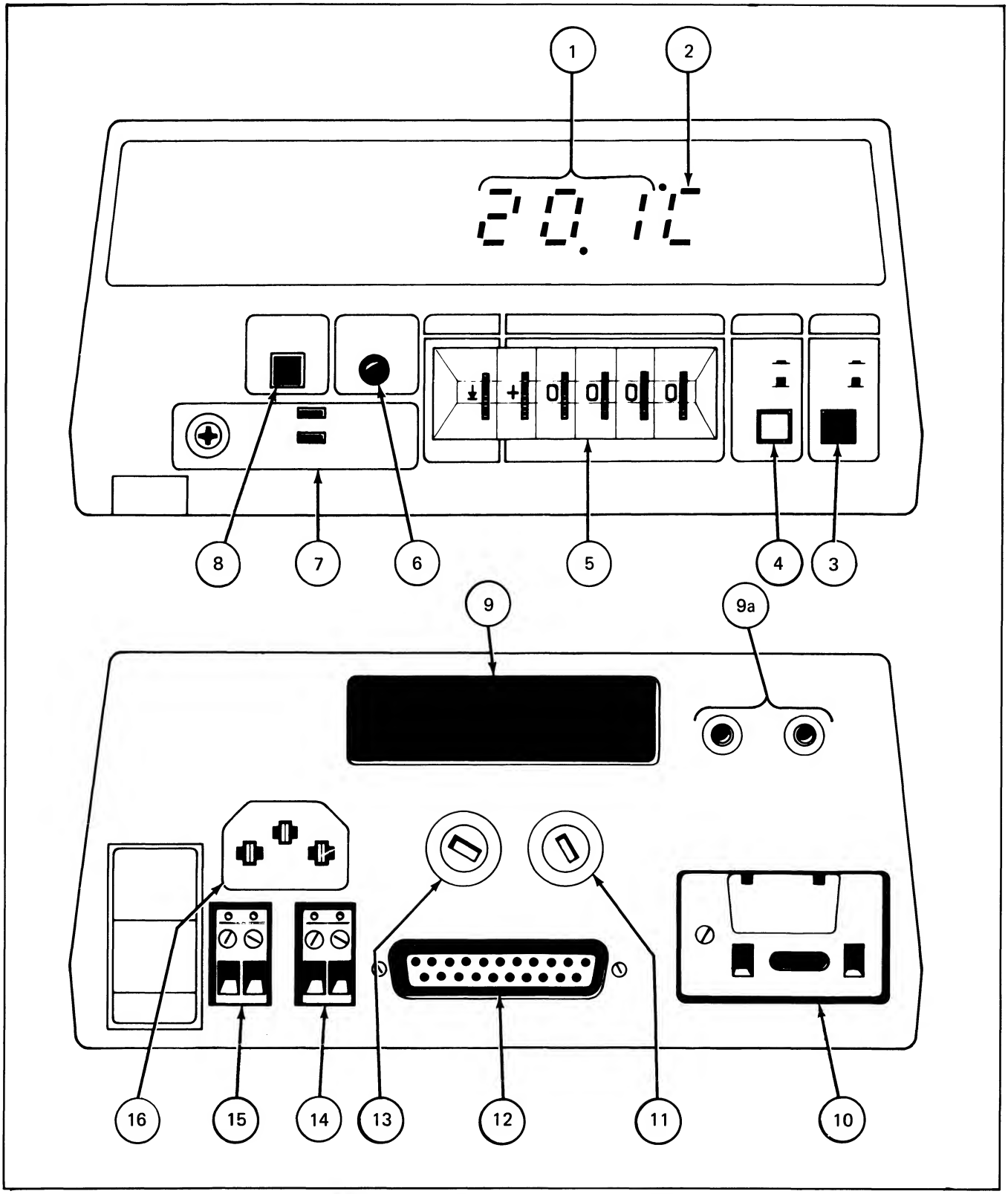


Figure 2-1. Controls, Indicators and Connectors

Table 2-1. Controls, Indicators and Connectors

REF	NAME	FUNCTION
1	Digital Display	Displays a five digit readout of the measured input temperature. Leading zero suppression and a variable position decimal point are included. A minus sign is displayed for negative temperature measurements. Flashes when overranged.
2	Temperature Scale Indicator	Displays the temperature scale represented by the digital display data: °C or °F.
3	Power Switch	Push on/Push off.
4	SCALE	Selects the temperature scale for display: °C or °F.
5	LIMIT and FUNCTION	Part of the –006 Limits Option. When installed, the thumbwheels may be set to a four digit LIMIT value (+ or –). The FUNCTION thumbwheel can then be set to define the limit value and signal (LIMIT EXCEEDED) when the displayed temperature has exceeded the limit value (>, ≤). Display will read the difference between the thumbwheel setting and the actual temperature when (△) is set in FUNCTION. Set FUNCTION thumbwheel for storage of maximum ($\overline{1}$) or minimum ($\underline{1}$) measured since last initializing (no limit value settings).
6	LIMIT EXCEEDED	Part of the –006 Limits Option. Indicator illuminates when the preset limits have been exceeded.
7	CALIBRATION COVER	Sliding cover for calibration adjustments.
8	INITIALIZE MAX/MIN	Part of the –006 Limits Option. Resets the previous maximum and minimum readings stored by the microcomputer.
9	DIGITAL OUTPUT	Connector for the ASCII coded data for the Output Unit, if 21X0A-002 is installed. Connector for the IEEE-488 if 21X0A-004 is installed (instead of 21X0A-002).
9a	ANALOG OUTPUT	Banana jack connector for an Analog Output (1 mV per degree), if 21X0A-002 is installed. (Only used with 21X0A-002.)
10	RTD INPUT MODULE	Removable module houses RTD input connections and type selection switch.
11	F2	External 12V dc input fuse (3/4A MDL slo-blo).
12	ACCESSORY CONNECTOR	Cable connector for accessory bus connection from accessory units.
13	F1	Input line power fuse 1/8A (100 or 120 VAC) 1/16A (220 or 240 VAC). MDL (slo-blo).
14	LIMITS	When the Limits Option is installed, it provides contact closure when the set limit has been exceeded.
15	±12 VDC	Input terminals for the external 12V dc power source.
16	LINE VOLTAGE CONNECTOR	Input connector for the input line voltage.

2-16. OPERATING NOTES

2-17. The following paragraphs describe various conditions that could affect operation of the thermometer. The operator should familiarize himself with these conditions prior to operating the 2180A.

2-18. Option Information

2-19. Supplementary operating instructions are necessary when operating the 2180A equipped with one of the available options. Detailed information regarding the operation of each available option is given in Section 6 of this manual, Option and Accessory Inforamtion.

2-20. Fuse Replacement

2-21. The ac line input and external dc input are individually fuse protected. Both fuses are readily accessible on the outside of the rear panel. The ac line input fuse (F1) should be replaced with a 1/8A MDL (slo-blo) fuse if either 100 or 120 volt operation has been selected. Use a 1/16A MDL (slo-blo) replacement for 220 or 240 volt operation. The external dc input (F2) requires a 3/4A MDL (slo-blo) fuse for a replacement.

CAUTION
Remove the power connector from the 2180A before changing fuses.

2-22. RTD Installation

2-23. Use the following procedure when installing an RTD and conducting temperature measurements:

1. Set POWER switch to OFF.

2. Remove the RTD Input Module from the instrument (rear panel).

3. Route the selected RTD lines through the Input Module's rear access port, and connect them to the input terminals; depending on the type of RTD, connections may involve 2, 3, or 4 wires. Refer to Figure 2-2 as a reference when connecting RTD lines to the Input Module (TB1). Lines of the same color usually go to the same polarity connections (+V and +S, or -V and -S). Refer to instructions included with the RTD for specific connection directions.

NOTE

When 2- or 3-wire RTDs are used, there is some error created due to the RTD excitation current in the Sense (S) wire leads. To minimize this error. The user should (when possible) use the 4-wire RTD connection as show in Figure 2-2.

4. On the Input Module, toggle the RTD Selector Switch (S1) to obtain the desired RTD type, see Table 2-2.

NOTE

The RTD Input Module may be printed with microcomputer Type #1 selector switch settings. Refer to Table 2-2 when changing RTD types.

5. Slide the Input Module, RTD lines attached, back into the 2180A securely.

NOTE

Refer to Section 6 of this manual or applicable accessory manuals for instructions on the operation of any installed options or connected accessories.

6. Set POWER switch to ON.

7. Expose the RTD to a temperature within the RTD's specified range (see Specifications in Section 1).

8. The RTD temperature, in the scale selected, is displayed on the front panel.

NOTE

R2 on the 2180A is adjusted at the factory with a 100 ohm input resistance. If the 2180A is used with a 100 ohm 385 Pt RTD probe meeting DIN standard #43760, then the R2 adjustment in the following paragraph may be ignored.

9. Adjust R2 on the RTD Input Module to compensate for variations in lead resistance and in RTD probe Ro values. Refer to Section 4 for RTD input module adjustment procedures. This adjustment must be performed when an RTD probe is initially installed and whenever the leads or the RTD are changed.

NOTE

The RTD adjustment can be used to calibrate the 2180A and the probe near a specific temperature. Adjust R2 for compatibility between the 2180A and a customer supplied temperature reference.

2-24. OPERATING DIRECTIONS

2-25. Operate the 2180A Thermometer using the following procedure:

1. Verify the instrument has the correct RTD connected.

2. Connect the input line cord to the applicable power source.

3. Select the temperature scale desired for display by pressing the Front Panel SCALE switch (in for °C, and out for °F).

4. Set POWER switch to ON.

2-26. Additional Features

2-27. The following paragraphs describe how the 2180A may be used to measure voltage or resistance. In both cases, the RTD will be replaced with a length of standard electrical wire. To connect the standard wire to the RTD Input Module, use steps 1-3 of the RTD Installation procedure, ignoring all reference to the RTD.

2-28. HOW TO MEASURE VOLTAGE

2-29. The 2180A can be used to measure positive voltages only up to +100 mV or +1V maximum in two ranges, with 1 μV or 10 μV resolution respectively. To obtain the desired range, refer to the following steps and Figure 2-3.

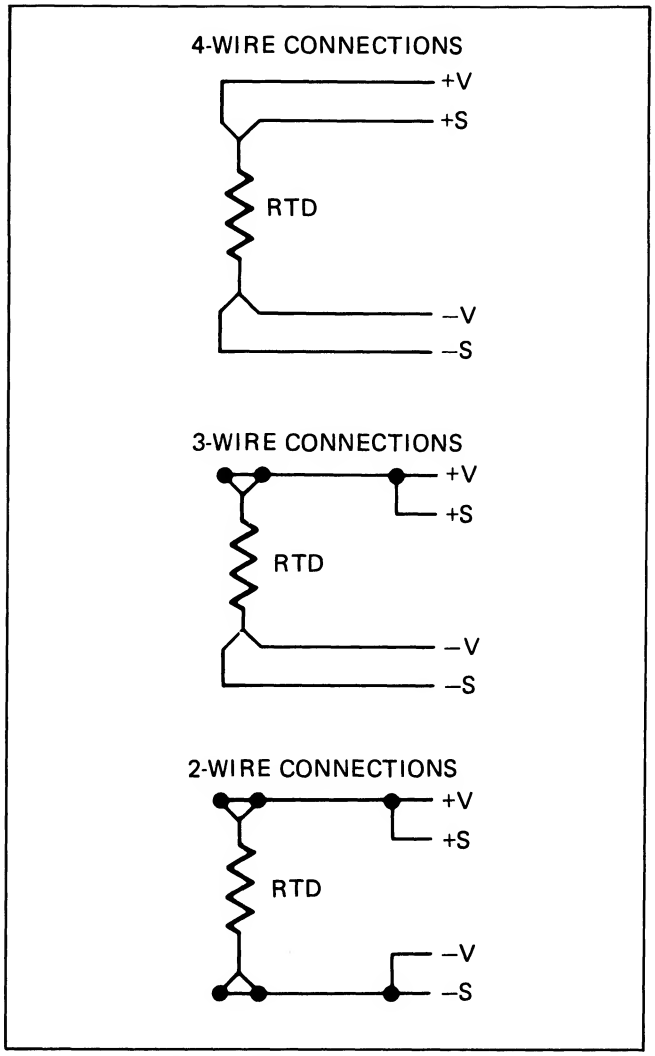


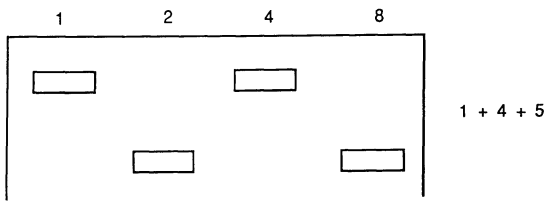
Figure 2-2. RTD Connections

Table 2-2. RTD Input Module Switch Settings

TYPE μP	DISPLAY READING AT TURN ON	RTD SELECTOR SWITCH (S1) SETTINGS									
		0	1	2	3	4	5	6	7	8	9
2	8002.2	100* 385**	100* 390**	100* 3916**	100* 392**	100* NI	10* CU	—	—	OHM	CAL

* = OHMS
** = PLATINUM

EXAMPLE: To select a switch setting of 5, position the RTD selector switch (1) as shown:



1 + 4 + 5

Table 2-3. RTD Input Module Switch Functions

SWITCH NO.	SWITCH POSITION	SWITCH FUNCTIONS
S1	0 - 5	Programs the microcomputer (μc) for each RTD probe type (See Table 2-2.)
	6, 7	NOT USED
	8	"RESISTANCE", programs the μc to read ohms.
	9	"CAL". programs the μc to read μV (bypasses the linearization program).
S2	.1	Causes the analog to digital converter circuitry (A/D) to have 10 μV input sensitivity and displays temperature to 0.1° resolution only.
	AUTO	Causes the A/D to automatically change from .01° to 0.1° resolution for overrange or 0.1° to .01° resolution for underrange.
S3	Scan	Not Used
	Man	MUST BE LEFT IN THIS POSITION DURING NORMAL OPERATION.

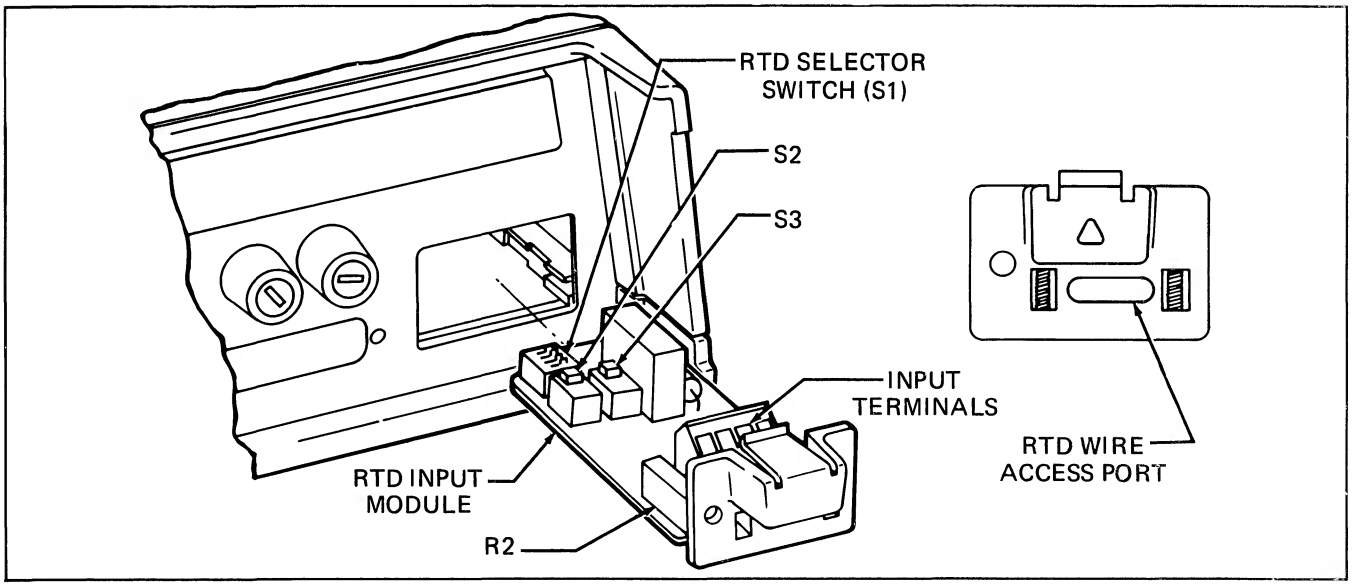


Figure 2-3. RTD Input Module Access

NOTE

The decimal point and temperature scale indicator (°C/°F) should be ignored during the following steps, the user must be aware of the selected range.

2-30. 100 millivolt Range

1. Install lead wire to the RTD Input Module, refer to RTD Installation procedures, steps 1-3 (this section).

2. Set RTD Input Module switches, S1 to position 9 and S2 to AUTO.

3. Replace RTD Input Module and turn 2180A on.

4. The 2180A is now ready to measure positive voltages up to +100 mV.

2-31. 1 Volt Range

1. Install lead wire to the RTD Input Module, refer to RTD Installation procedures, steps 1-3 (this section).

2. Set RTD Input Module switches, S1 to position 9 and S2 to .1°.

3. Replace RTD Input Module and turn 2180A on.

4. The 2180A is now ready to measure positive voltages up to +1V.

2-32. HOW TO MEASURE RESISTANCE

2-33. The 2180A can be used to measure positive resistances up to 999.9Ω with 10 mΩ resolution (RTD excitation ≈0.5 mA). To set up the 2180A as a resistance measurement device, refer to the following steps and Figure 2-3.

NOTE

The temperature scale indicator (°C/°F) should be ignored during the following steps.

2-34. Resistance Measurements

1. Install lead wires to the RTD Input Module, refer to RTD Installation procedure, steps 1-3.

2. Set RTD Input Module switches, S1 to position 8 and S2 to .1°.

3. Connect a known resistance, less than 1 kΩ, to the wires connected to the RTD Input Module, and use the following steps to compensate for lead resistance.

4. Replace RTD Input Module and turn 2180A on.

5. Adjust R2 through the rear panel of the RTD's Input Module until the 2180A's display reads the same value as the known resistance.

6. Remove the known resistance, the 2180A is now calibrated and ready to measure positive resistances up to 999.9Ω.

NOTE

For measuring resistances of less than 196Ω, switch S2 on the RTD Input Module should be set to the AUTO position.

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Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual contains an overall functional description and a brief circuit analysis of the 2180A Digital Thermometer. Simplified circuit diagrams are provided, as necessary, to supplement the text. Detailed schematics are given in Section 8 of this manual.

3-3. The Model 2180A is a single point RTD Digital Thermometer with 0.1° and .01° resolution for either degrees F or C. This instrument features dual slope A/D conversion, microcomputer control logic, and a 5-digit display with temperature scale indicator. Various RTD types can be used over a temperature range of -394° F to 1435° F (-219°C to 664°C). Refer to Figure 3-1 for the following functional description. Mnemonic definitions are provided in Table 3-1.

3-4. FUNCTIONAL DESCRIPTION

3-5. The Model 2180A executes a continuous series of measurement cycles. These cycles, controlled entirely by a microcomputer, include three major periods: the Auto-Zero, the Integrate, and the Read periods. During each period, digital controls are applied to the analog section of a dual slope converter. The converter in turn generates a compare output. The configuration of the analog section during each phase of the measurement cycle is established by the condition of microcomputer controlled FET switches.

3-6. The measurement cycle begins with the Auto-Zero period. During this period, the input to the Buffer Amplifier is connected to ground through an FET switch and the accumulated dc offset voltages present in the analog section are sampled and held by the Auto-Zero capacitor. This voltage is used later in the measurement cycle to cancel measurement errors introduced by offset voltages in the analog circuitry. The final measurement is therefore proportional to the RTD probe output voltage and does not include offset errors.

3-7. During the Integrate period, the RTD input voltage read across the RTD, is applied to the integrator. The algebraic sum of the AZ and RTD input voltages is integrated over a 100 ms period. At the end of this period, the RTD input voltage is removed from the integrator, and the Read period is started.

3-8. A reference voltage is applied to the integrator during the Read period, causing the integrator capacitor to be discharged at a linear rate. When the integrator output reaches zero, a compare signal is generated to end the Read period. The duration of the Read period is translated by the microcomputer, to provide a digital indication of the RTD temperature.

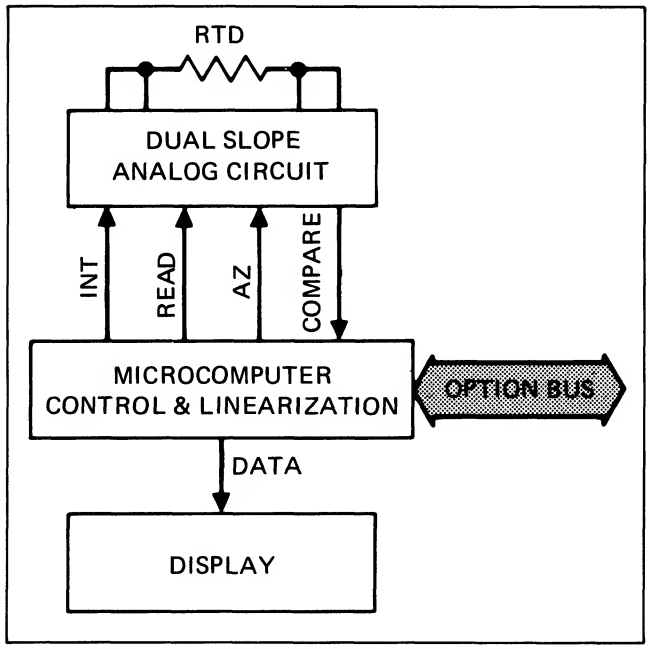

Figure 3-1. 2180A Simplified Block Diagram

Table 3-1. Mnemonics

ANALOG COM	Measurement common
AZ	Auto-Zero
CM	Compare input to the microcomputer
$\overline{\text{DATA}}$	Data on bus
$\overline{\text{DCLK}}$	Data clock
DE+	Positive read command
DE–	Negative read command
DIGITAL COM	–15V with respect to Analog Com
D.P./NEG	Drives decimal point, depending on reading and resolution
INT 1	Causes the unknown voltage to be integrated
$\overline{\text{LINEAR}}$	Used to command the microcomputer to display linear counts
$\overline{\text{WRT}}$	Write
$\overline{\text{WRT ADR}}$	Write address, signals that an address is being transmitted
X10	Selects a buffer gain of X10 (0.1° resolution)
X100	Selects a buffer gain of X100 (0.01° resolution)
△ 2	Hold command
+ SENSE	Voltage sense wires from RTD - no current flows in these wires
–SENSE	Voltage sense wires from RTD - no current flows in these wires
+Vm	An intermediate voltage - not used directly
–V	Current return

3-9. CIRCUIT ANALYSIS

3-10. Circuit analysis of the 2180A is discussed in two sections: digital and analog. The digital section is covered first; particular attention is paid to digital control of the analog section. The analysis of the analog section covers the analog measurement circuitry and the 2180A power supply.

3-11. Digital Section

3-12. The digital section of the 2180A consists of a single-chip microcomputer with a self-contained, programmed, read only memory (U9), a hex CMOS open drain buffer (U13), and an LED display. This section, shown in Figure 3-2, will provide the following functions:

1. Conversion of the non-linear RTD probe voltage, as measured by the analog section, into a linear digital display.

2. Control of the analog section.

3. Control of all accessories on the accessory bus.

3-13. The microcomputer (U9) contains all of the 2180A programming, control logic, and linearizing capability. It also provides all signals necessary to update the display. Linearization of the RTD signal is accomplished by using a piece-wise, 4th order, curve-fit approximation for each type of RTD. One of the seven operating programs is selected for the RTD type by setting S1 on the RTD Input Module. A table showing RTD switch setting numbers and corresponding RTD types is printed on the RTD Input Module PCB.

3-14. Measurement data is continuously strobed out of the microcomputer in decoded-seven-segment, bit-parallel, character-serial format. This data is then sent to the LED display.

3-15. The total measurement cycle takes 300 ms. The cycle consists of the following periods:

1. Auto-Zero period (100 to 200 ms).

2. Integrate period (100 ms). A 1 ms nominal hold signal is inserted at the beginning and end of the Integrate period to accomodate settling times in the analog section.

3. Read period (variable 0 to 100 ms).

3-16. Analog Section

3-17. ANALOG MEASUREMENT CIRCUIT

3-18. The analog measurement circuitry consists of an RTD input circuit, two voltage reference circuits, a ground sense amplifier, a buffer amplifier, a dual slope

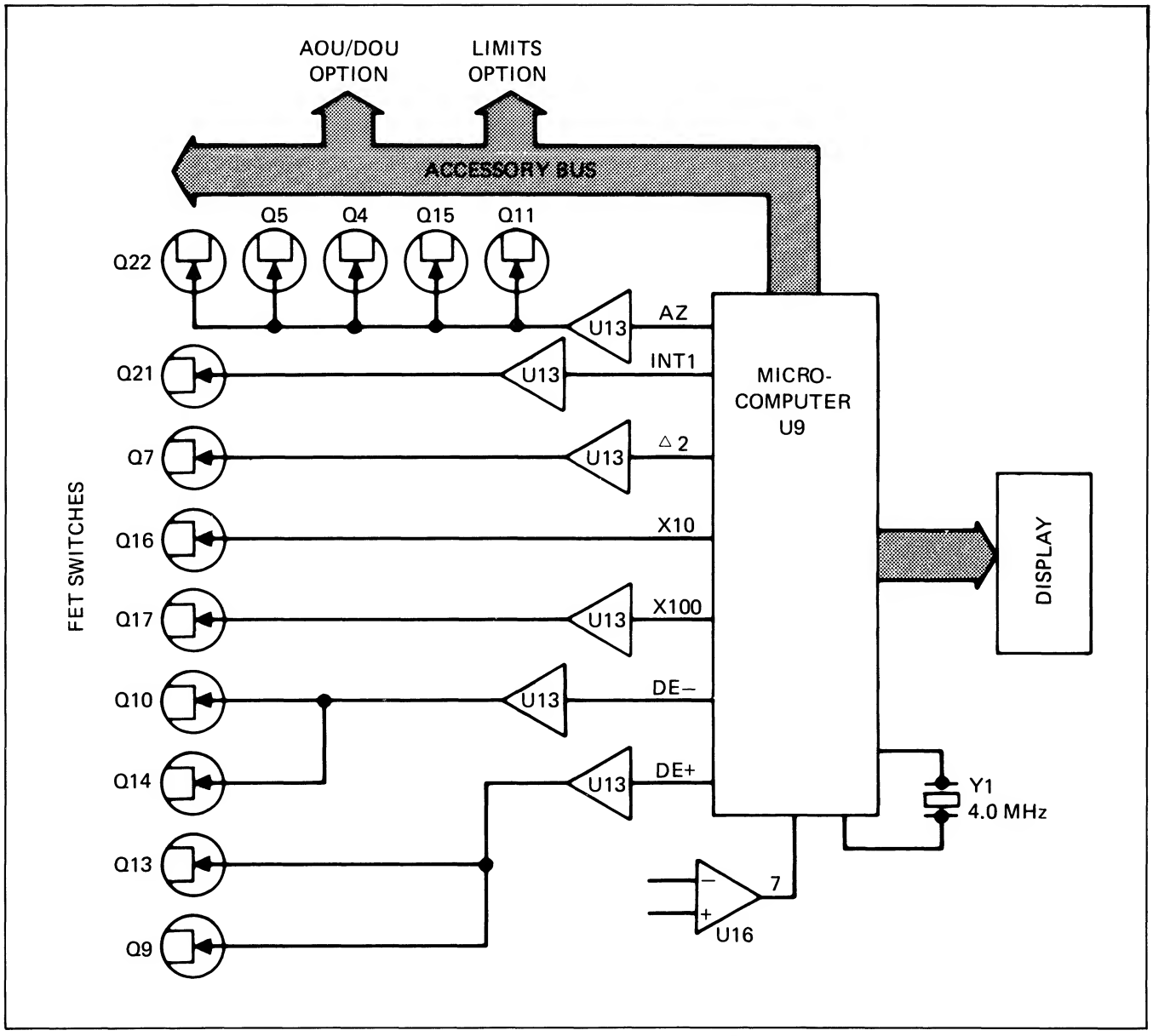

Figure 3-2. Simplified Schematic — Digital

A/D Converter (integrator, gain stage, and comparator), and a combination of FET switches. Refer to Figure 3-3 in conjunction with the following individual circuit descriptions. All FET switches will be shown in their open state; they are closed during measurement cycle commands from the 2180A's digital section.

3-19. The RTD Input circuit comprises the RTD probe, the RTD Input Module, and a low pass filter on the Input Module's PCB. Source current flows through a series combination of the RTD probe, R2 (RTD Input Module), and R1 (Main PCB). The voltage sensed across the RTD is routed through the Input Module, and onto the Main PCB. The +Sense line (always a positive voltage) is then applied to the low pass filter.

3-20. The ground sense amplifier (Q20, U7 and associated circuitry) maintains the -Sense line at measurement ground. This amplifier compensates for noise and offsets on the -V and -Sense lines.

3-21. To achieve switching between 0.01° and .1° resolution, the buffer gain is shifted by a factor of ten. For 0.01° resolution, FET switch Q17 is on, and a reference voltage of -100 mV is applied to the buffer (Q19, U5). The buffer gain is set to 100. For 0.1° resolution, FET switch Q16 is on, and a reference voltage of -1.00V is applied and the buffer gain is 10.

3-22. The first voltage reference consists of a resistor network supplied by an accurate 6.2V dc reference voltage. The resistive divider network is set to provide 200 mV to Q14, 100 mV to Q15, 1.0V to Q11,and 2.0V to Q10.

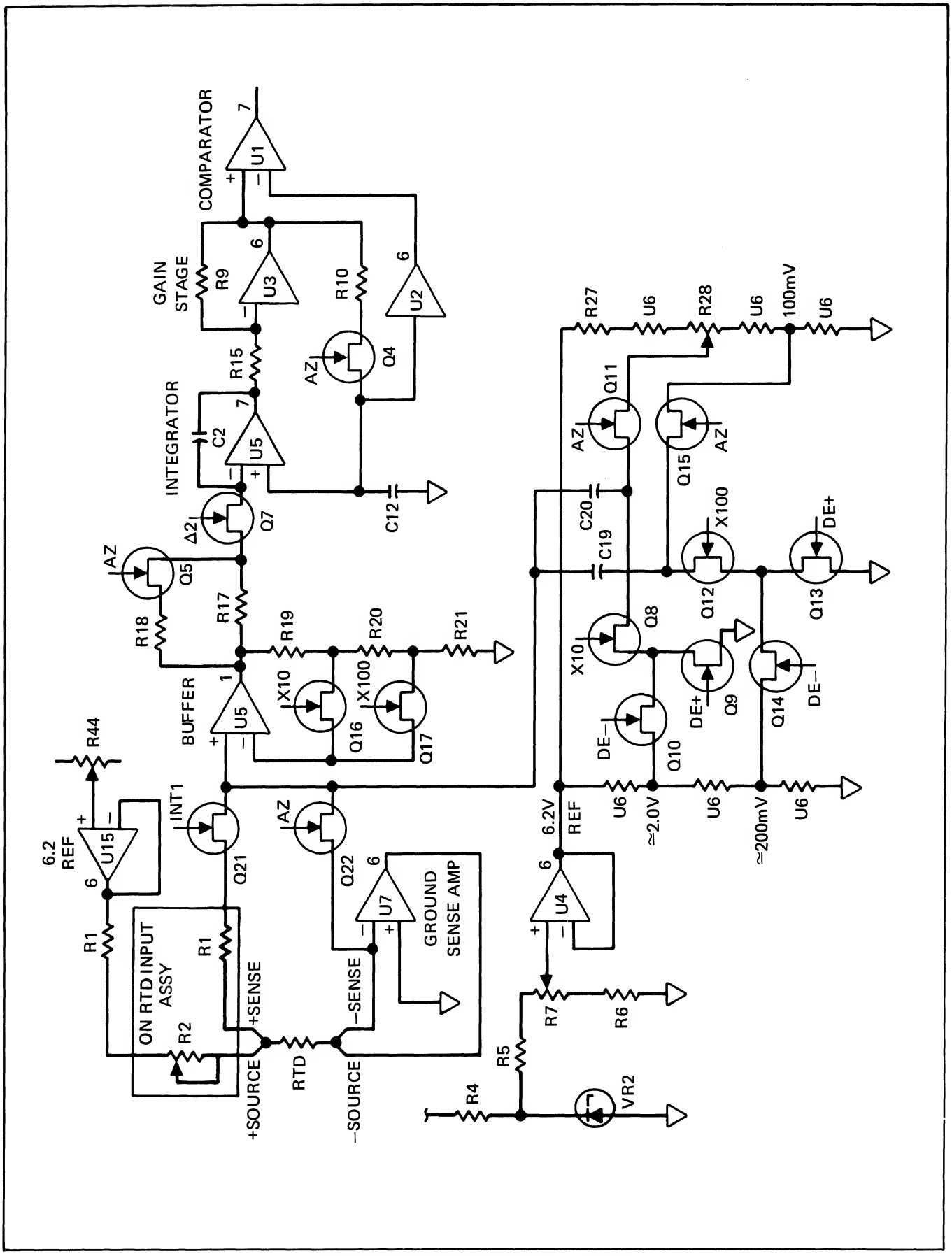

Figure 3-3. Simplified Schematic — Analog

When 0.01° resolution is in use, Q12 will allow reference capacitor C19 to attain a -100 mV charge. For 0.1° resolution, Q8 will allow C20 to charge to °1.0V. Either reference capacitor will be placed at the -Sense level during Auto-Zero. Recovery deintegrate is applied to Q10 and Q14.

3-23. A second voltage reference (U15-6) provides an accurate 6.2V across the series combination of R1 (Main Thermometer PCB), R2 (RTD Input PCB), and the RTD. This voltage therefore provides the source (+V) voltage for the RTD.

3-24. The Buffer, Integrator, Gain Stage, and Comparator Amplifiers combine to perform the analog functions of the Integrate, Read, and Auto-Zero periods. The Buffer is used to provide integrator inputs during all three periods. The Integrator integrates the Buffer output voltage during the Integrate and Read periods and, in combination with the Gain Stage, functions as a closed-loop amplifier during the Auto-Zero period.

3-25. An Auto-Zero period is commanded during the first phase of each measurement cycle. During this time, five auto-zero switches (Q4, Q5, Q11, Q15, and Q22) are closed by the microcomputer. Three of the switches (Q11, Q15, and Q22) charge the reference capacitors to +100 mV on C19 and +1.0V on C20. Closing switch Q4 connects the Integrator and Gain Stage into a closed-loop configuration. This action also allows the Auto-Zero capacitor (C12) to charge to a value proportional to the algebraic sum of all the offset voltages in the Buffer, Integrator and Gain Stage. At the end of the Auto-Zero period, switches Q4, Q5, Q11, Q15, and Q22 are opened. The reference capacitors (C19 and C20) and the Auto-Zero capacitor retain their charges for later use in the measurement cycle.

3-26. The Integrate period (see Figure 4-4) starts on the leading edge of the integrate command from the microcomputer; switch Q21 is closed and switch Q7 is opened. The RTD input voltage is applied through switch Q21 to the Buffer input. After a 1 ms settling period, switch Q7 closes, and the Buffer output is applied to the Integrator for 100 ms. As the integrator capacitor C2 charges, the Integrator drives the comparator, through the gain stage to +5V dc which indicates that the charge on C2 is more negative than the Auto-Zero Reference C12. At the end of the Integrate period, the integrate capacitor is charged to a level and polarity proportional to the RTD voltage, and switches Q21 and Q7 return to the open state.

3-27. The Read period starts at the end of the Integrate period. Depending upon the input polarity sensed by the comparator during the Integrate period, one of two Read modes is enabled if a positive input is sensed, a positive Read mode is enabled. Similarly, a negative Read mode is enabled when a negative input is sensed.

3-28. When the positive Read mode is commanded, FET switches Q13 and Q9 are closed. If 0.1° resolution is in effect, Q8 will place the positive side of reference capacitor C20 at ground. With 0.01° resolution in effect, Q12 will place the positive side of reference capacitor C19 at ground. Reference capacitors C20 and C19 will then apply either -1.0V or -100 mV, respectively, to the Buffer input.

3-29. When the negative Read mode is commanded, switches Q10 and Q14 are closed; Q9 and Q13 are open. With .01° resolution selected, approximately +200 mV will be applied to the positive side of reference capacitor C19. The algebraic sum of the voltage at the Buffer input will then be +100 mV. When 0.1° resolution is selected, approximately +2.0V will be applied to the positive side of reference capacitor C20. Buffer input voltage will then be +1.0V (only during recover deintegrate).

3-30. After a 1 ms settling time, switch Q7 closes and the Buffer output voltage is applied to the Integrator input. The integrator capacitor now begins to discharge at a linear rate (determined by the reference voltage). This discharge continues until the integrator voltage reaches the comparator trip point, which is referenced to the voltage on the Auto-Zero capacitor. When this level is reached, the comparator changes state, commanding the microcomputer to terminate the Read period. To facilitate auto-zero, the microcomputer then calls a reference voltage opposite in polarity to the one previously used (DE- or DE+). When the integrator reaches the trip point, the microcomputer immediately begins the Auto-Zero period.

3-31. Offset voltages present during the Integrate and Read periods are cancelled by offset voltages that were sampled and held during the Auto-Zero period.

3-32. POWER SUPPLY

3-33. The 2190A Power Supply consists of a DC to DC Converter and regulating circuitry. AC inputs are made via the input power cord, line fuse, and power transformer/rectifier. External +12V dc inputs can also be made directly to the DC to DC Converter circuitry via line TB1 (see Main PCB schematic, Section 8). The function of the power supply is to provide +5V, +5V unregulated, +15V, and -15V dc operating voltages for the 2180A circuitry. The power supply can be driven from ac line or 12V dc external source. The DC to DC conversion and voltage regulation is accomplished using conventional power supply design techniques.

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Section 4
Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual provides information about warranty, factory service, maintenance, performance testing, routine recalibration and recalibration after repair. The performance test is recommended when the instrument is received and later as a preventive maintenance tool or for testing after repair. The test verifies performance at several temperatures within the range of a given RTD type. Specifications are provided both for annual and for a more precise 90-day performance-testing cycle.

4-3. SERVICE INFORMATION

4-4. The instrument is warranted for a period of 1 year upon delivery to the original purchaser. The WARRANTY is located on the back of the title page of this manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of these service centers is included in Section 7 of this manual. If requested, an estimate will be provided to the customer before any work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Instrument Disassembly and Resassembly

4-8. Disassemble the thermometer using the following procedure (power cord disconnected):

1. Remove the RTD Input Module through its access port in the rear panel.

2. On the bottom of the instrument, remove the four securing screws. Lift the top cover free.

3. Remove the screw securing the center of the Main PCB to the bottom portion of the case.

4. Lift the Main PCB, complete with Front and Rear Panels, clear of the case.

5. Remove the Output Option, if installed and required, by removing the three screws connecting it to the Main PCB, disconnecting the interconnect cables at J1 and J3, and lifting the Output Option PCB clear.

6. Remove the Front Panel, if required, by disconnecting the guard screw at the lower right corner; disconnecting the Front Panel Interconnect cable at J6; disconnecting, if installed, the Limits Option interconnect cable at J4; and moving the Front Panel forward.

7. Remove the Rear Panel, if required, by removing the three screws attaching it to the Main PCB, disconnecting the wires from the input line power connector, unsoldering the wires from two fuse holders and moving the rear panel free.

8. Perform reassembly in the reverse order.

4-9. Input Power

4-10. Input line power voltage is selected by positioning the two switches on the right edge of the Main PCB. Each switch (S3 and S4) has a position identifying slot; Figure 4-1, shows these slots positioned for 120V ac operation. Table 4-1 lists the switch settings for other line voltages.

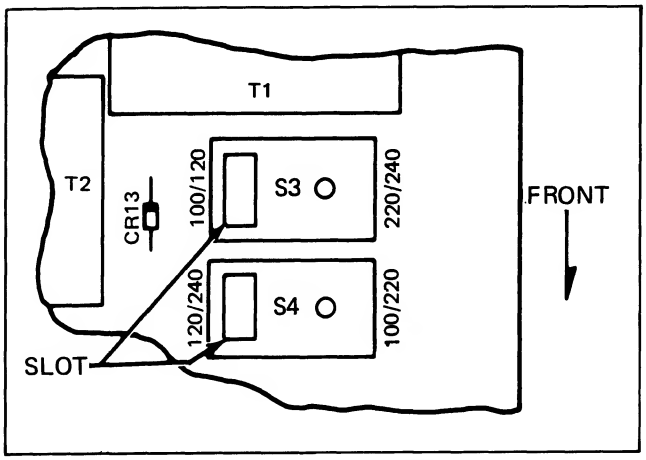


Figure 4-1. Line Voltage Selection

Table 4-1. Line Voltage Selection

VOLTAGE	S3 SLOT (REAR SW)	S4 SLOT (FRONT SW)
100	Left	Right
120	Left	Left
220	Right	Right
240	Right	Left

4-11. Cleaning

4-12. Clean the instrument periodically to remove dust, grease and other contamination. Use the following procedure:

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They will react with plastic materials used in the manufacture of the instrument.

1. Clean the front panel and case with a soft cloth dampened with a mild solution of detergent and water.

2. Clean the surface of the pcb using clean, dry air at low pressure (≤20 psi). If grease is encountered, spray with Freon T.F. Degreaser or anhydrous alcohol and remove grime with clean, dry air at low pressure.

4-13. Fuse Replacement

WARNING

DISCONNECT THE UNIT FROM LINE POWER BEFORE ATTEMPTING FUSE REPLACEMENT.

4-14. The 2180A has two fuses, both accessible on the rear panel. F1 is for the input line power and should be replaced, when necessary, with a 1/8A MDL (slo-blo) fuse when the input line power selected is 100V or 120V. When the input power selected is 220V or 240V, F1 should be replaced with a 1/16A MDL fuse. F2 is for the 12V dc external power and requires a 3/4A MDL fuse.

4-15. Service Tools

4-16. No special tools are required for maintenance or repair.

4-17. Static Discharge Precautions

4-18. Static discharge can damage components contained in the 2180A. The following precautions should be observed when conducting adjustments or repairs with the instrument's top cover removed.

1 Never conduct repairs without first pressing power OFF, disconnecting the line cord and accessory bus cable from the ACCESSORY CONNECTOR.

2. Perform all repairs at a static-free work station.

3. Minimize handling of ICs and the pcb; in no case handle them by their connectors.

4. Keep repair parts in their original container until ready for use.

5. Use static ground straps to discharge repair personnel.

6. Use conductive foam or anti-static containers to store replacement or removed ICs.

7. Remove all plastic, vinyl, and styrofoam products from the work area.

8. Do not slide static sensitive devices over any surface.

9. Use only anti-static type solder removal tools.

10. Use grounded tip soldering irons.

4-19. PERFORMANCE TEST

4-20. The Performance Test verifies instrument performance to specifications and may be used for initial acceptance, verifying calibration, or as an aid in troubleshooting. If the thermometer fails to meet specifications either the Calibration Adjust Procedure or Troubleshooting should be performed, as determined by qualified service personnel.

4-21. Table 4-2 lists the equipment required for the Performance Test and Calibration Adjustment Procedure. If the recommended model of test equipment is not available, a substitute that meets the minimum use specifications may be used. The test should be conducted with an ambient temperature of 25 ± 5°C (73.4 ±9°F).

4-22. Use the following procedure for the Performance Test:

1. Set the POWER switch to OFF and remove the line power cord from the line voltage source.

2. On the RTD Input Module, position S1 to 9 and S2 to AUTO.

3. Connect the equipment as shown in Figure 4-2. Refer to Table 4-2 for Recommended Test Equipment.

4. Verify the POWER switch is OFF, then adjust the line voltage transformer for the nominal input line voltage.

5. Set the POWER switch to ON.

6. Allow the thermometer to stabilize (at least 20 minutes).

7. On the Decade Resistance Box, select 100.00Ω and adjust R2 on the RTD Input Module for a display of "51240" (equivalent to 0°C or 32°F).

8. Refer to that portion of Table 4-3 pertaining to the RTD(s) in use.

9. On the Decade Resistance Box, select the first resistance listed in Table 4-3 for the RTD type being verified.

10. On the RTD Input Module, set the selector switch for the RTD type to be verified (0-5). Refer to Table 2-2 for switch settings.

11. Verify that the 2180A reading is within the tolerance listed in Table 4-3 (90-day or 1-year).

12. Repeat steps 9, 10, and 11 for the remaining resistances listed for the RTD type being verified.

13. Repeat steps 9-12 for as many RTD types as necessary.

14. Set the line voltage transformer for line voltage minus ten percent and repeat the test for one RTD type.

15. Set the line voltage transformer for line voltage plus ten percent and repeat the tests for one RTD type.

16. Set the line voltage transformer for the input line voltage.

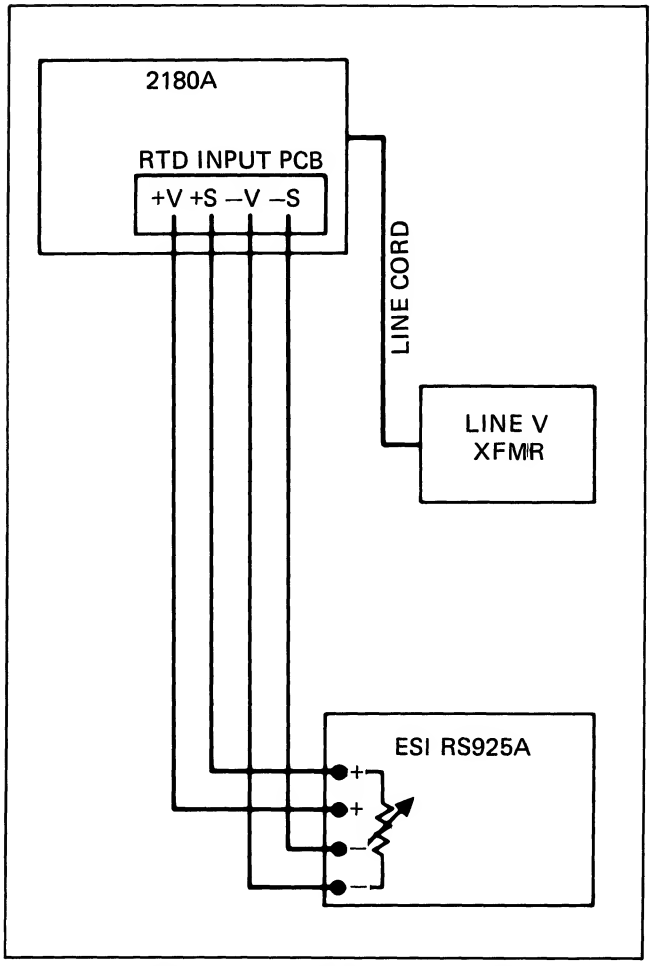


Figure 4-2. Performance Test Connections

Table 4-2. Recommended Test Equipment

TEST EQUIPMENT	MINIMUM USE SPECIFICATIONS	RECOMMENDED MODEL
Variable Line-Voltage Transformer	100, 120, 220, 240V ac, as required, ±10%	General Radio VARIAC W5HM
Decade Resistance Box	.01Ω resolution	General Radio 1433T, ESI Model RS925A, or equivalent
Voltage Divider	100:1	Fluke Y2022 or equivalent
Calibrator (DC Source)	10 μV resolution	Fluke 343A or equivalent
Digital Voltmeter (±100 μV)	100 μV resolution, on 10V range	Fluke 8800A or equivalent
Lag Bath	Temperature Stable, .01° resolution	Customer Constructed. (See Lag Bath Construction, this section)

4-23. CALIBRATION

4-24. The thermometer should be calibrated at either 90-day or annual periods, depending upon the accuracy desired, and any time that repairs are made to the instrument. Conversion between Fahrenheit and Celsius scales is realized through a mathematical computation by the microcomputer. Calibration in °F is recommended. Calibration in either scale (°F or °C) insures the accuracy of the other. Either scale can be verified by executing the Performance Test.

4-25. Equipment Preparation

4-26. Prepare the equipment for calibration using the following procedure:

1. Remove the top cover from the instrument.

2. Apply power to 2180A and all test equipment to be used. Insure the 2180A warm-up period has been sufficient to reach rated accuracy (at least 20 minutes).

3. Select the desired temperature scale (°C or °F). If the Limits Option is installed select the LIMITS (≤ or >) function.

NOTE

Before removing the RTD Input Module, set power switch to OFF.

CAUTION

Do not connect analog common (0V) to digital common (-15V with respect to analog common). Instrument damage may result.

4-27. Reference Adjust

4-28. Perform Reference Adjust using the following procedure:

1. Connect the DVM between TP16 and TP1 (Analog Common).

2. Adjust R7 for a reading of 6.2V ±100 μV.

4-29. Reference Adjust (+V)

4-30. Perform the Reference Adjust for the +V using the following procedure:

1. Connect the DVM to TP17 (HI) and TP1 (LO - Analog Common).

2. Adjust R44 to obtain a reading of 6.2V ±100 μV.

4-31. Zero Adjust

4-32. Perform the Zero Adjust using the following procedure:

1. Connect the 2180A Digital Thermometer, DC Voltage Calibrator, and Voltage Divider as illustrated in Figure 4-3.

2. On the RTD Input Module, place a jumper between -V and -S on TB1. Select AUTO (S2 on the Input PCB).

Table 4-3. 2180A Performance Tests

OHM INPUT	SELECT SWITCH	READING °F	READING °C	90 DAY °F	90 DAY °C	1 YEAR °F	1 YEAR °C
39.650	(0) 100 ohm 385 Pt	-238.00	-150.00	.100	.054	.104	.057
212.030		572.0	300.0	.30	.17	.32	.19
345.210		1292.0	700.0	.44	.25	.49	.27
38.777	(1) 100 ohm 390 Pt	-238.00	-150.0	.044	.024	.049	.027
213.472		572.0	300.0	.25	.14	.28	.16
348.446		1292.0	700.0	.42	.24	.47	.26
38.679	(2) 100 ohm 3916 Pt	-238.00	-150.00	.100	.055	.105	.058
213.929		572.0	300.0	.28	.16	.30	.17
349.323		1292.0	700.0	.42	.24	.47	.26
38.612	(3) 100 ohm 392 Pt	-238.00	-150.00	.044	.024	.049	.027
214.135		572.0	300.0	.25	.14	.28	.16
349.909		1292.0	700.0	.39	.21	.43	.25
71.80	(4) 100 ohm NI	-67	-55.00	.26	.15	.27	.15
161.70		212	100.0	.37	.21	.38	.22
219.00		347	175.0	.39	.22	.40	.23
6.201	(5) 10 ohm CU	-100	-73.3	.33	.19	.34	.19
14.778		300	148.9	.35	.20	.37	.21

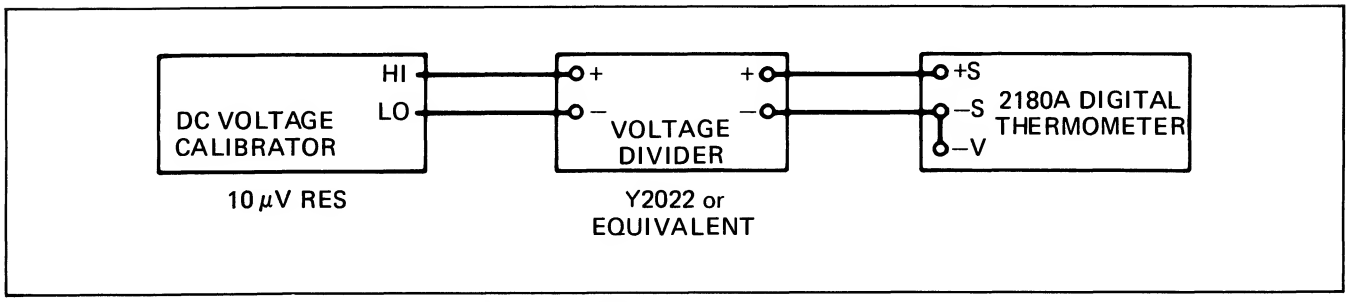


Figure 4-3. Calibration Connections

3. Toggle the RTD select switch for setting 9. Toggle S3 to manual position.

4. On the 2180A front panel, access calibration adjustments behind the cover in the lower left corner. Loosen the screw and slide the cover to the left.

5. Set the calibrator output to 0.00102V and divider to +100 (10.2μV to 2180A). Note the 2180A reading. Now reverse the input polarity and again note the reading. Adjust R29 (access beneath front panel calibration cover-ZERO) until the readings in both directions are the same.

6. Adjust R14 (Main PCB) for a reading of +10. Reverse input polarity and look for a 2180A reading of -10. Repeat steps 4 and 5 if a reading of -10 is not obtained.

4-33. Resolution Adjustments

4-34. Use the following procedure to adjust the 2180A's .01° and .1° display and the verify autoranging operation.

1. Replace the 2180A's top cover. Leave test equipment connected (DC Voltage Calibrator, Voltage Divider) as described in Zero Adjust instructions.

2. On the 2180A front panel, access calibration adjustments by loosening the screw and sliding the cover to the left.

3. On the RTD Input Module, set S2 to AUTO. Set input switch S1 to setting 9 (CAL).

4. Set the DC Voltage Calibrator output to 9.9V (99 mV to the 2180A).

5. Adjust R27 (.01° cal potentiometer) for a reading of 99000 ±1.

6. Change the calibrator output to 4.5V (45 mV to 2180A). The 2180A should read 45000 ±2.

7. Set switch S2 out of AUTO. Set DC calibrator output to 9.9V and the divider to 10 (990 mV to 2180A).

8. Adjust R28 (.1°C cal potentiometer) for a reading of 99000 ±1.

9. Change the calibrator output to 4.5V, the 2180A should read 45000 ±2 (450 mV to 2180A).

10. Place S2 in the AUTO position.

4-35. RTD Input Module Adjustment

4-36. Use the following procedure whenever 2180A calibration or repair has been accomplished or when a different RTD probe is installed.

1. Connect the RTD probe to the RTD Input Module (TB1).

2. Select the applicable input switch setting (S1) and insert the probe into a ice bath. Refer to the following paragraph for a suggested method of constructing a ice bath.

3. Install the RTD Input Module in the 2180A. Apply power to the 2180A.

4. Adjust R2 (access through the rear hole on RTD Input Module) until the 2180A displays the ice bath temperature.

5. Calibration of the 2180A is now complete. Disconnect all test equipment from the instrument.

4-37. Ice Bath Construction

4-37. Ice Bath Construction

4-38. The following instructions provide a recommended method of constructing a ice bath:

NOTE

Distilled water must be used to make the ice and must also be used in the ice bath.

1. Required material; supply of ice, distilled water, and an insulated jar with an unbreakable lid (thermos or equivalent).

2. Prepare the insulated jar by drilling one or more holes just large enough to accept the RTD Probe or Probes.

3. Fill the insulated jar with shaved or crushed ice.

4. Fill the insulated jar with enough distilled water so that the ice becomes slush but not enough to float the ice.

NOTE

As the ice melts, siphon off the excess water and add more ice. Allow about 5 to 10 minutes for the water to drop back to the freezing point.

4-39. SELECTED COMPONENT REPLACEMENT

4-40. Certain components in the two 6.2V reference supplies are supplied as a matched set. If a component in either set is replaced, all the components in that set must be replaced with a matched set supplied by John Fluke Mfg. Co., Inc. The two sets include R4, R5, and VR2 in the 6.2V reference and R43, R46, and VR5 in the 6.2V (V+) reference.

4-41. TROUBLESHOOTING

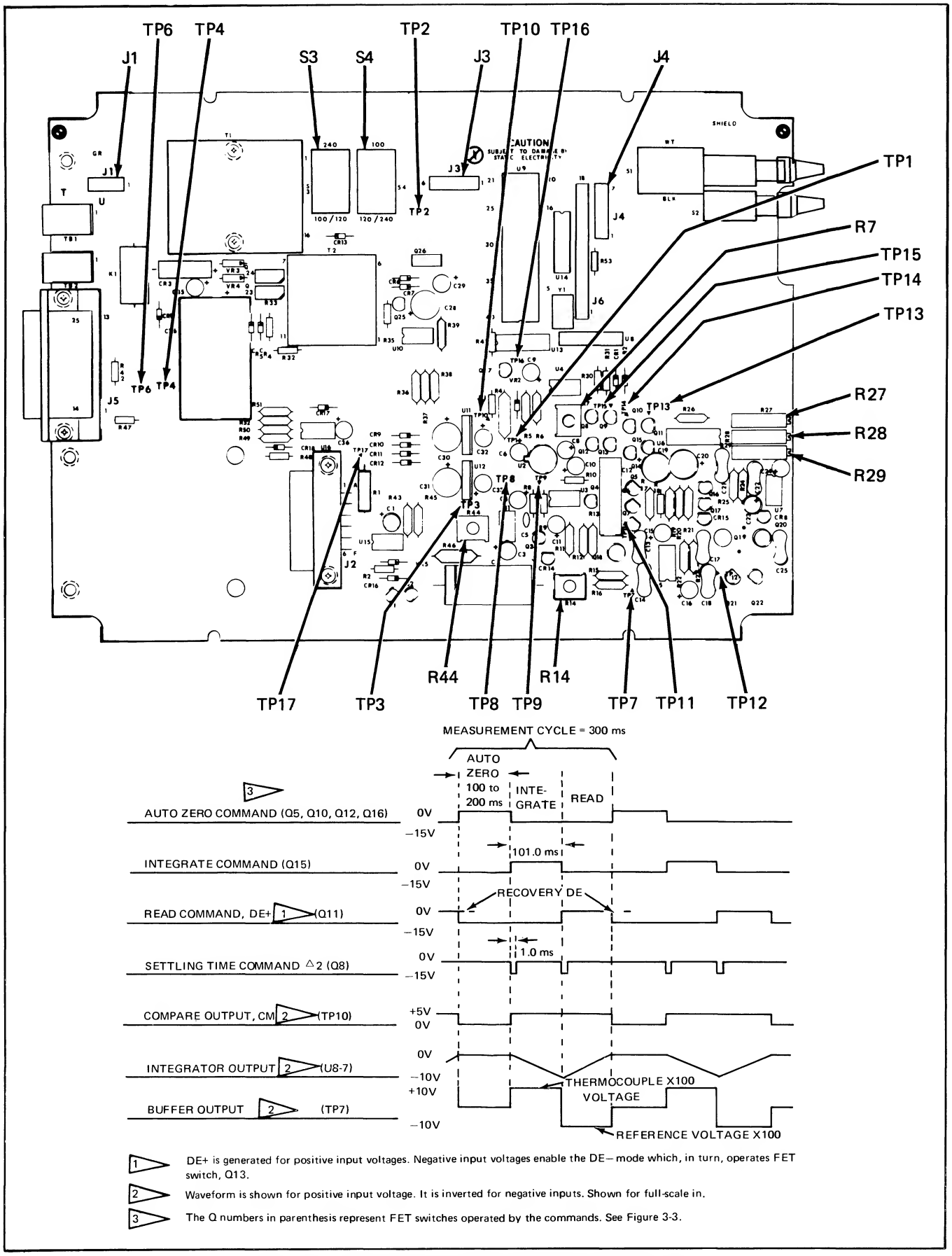
4-42. Troubleshooting for the 2180A consists of the tabular flow chart in Table 4-4. When a step on the flow chart is completed check for a decision transfer. If no decision is required perform the next step of the table in sequence. Refer to Figure 4-4 for test point location and Table 4-5 for test point identification.

Table 4-4. 2180A Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Input 0 volts from the divider to +S (HI); −S, −V (LO); leave +V disconnected.		
2	Set the RTD selector switch to setting 9 (Cal).		
3	Apply power to the thermometer.		
4	Does the display read 2180.X for ten seconds and then change to 0°C (0°F)?	14	5
	NOTE *X = a numeral depending on the version of software installed.*		
5	Does any portion of the display illuminate?	13	6
6	Measure between TP2 (REF) and TP4 for +5 ±10% VDC, between TP1 (REF) and TP3 for +15 ±5% VDC.		
7	Are all voltages correct?	12	8
8	Measure between pin 8 of T2 and the negative end of C26 for a DC voltage greater than 10.3V and for a peak-to-peak wave form between pins 8 and 9 of T2 approximately twice the value of the DC voltage measured at pin 8.		
9	Are both signals present and correct?	11	10
10	Check the inverter circuit that drives the transformer (T2). Repair as required then resume at step 3.		
11	Check the transformer secondaries and if any are bad, check the individual regulators and their associated components. NOTE: Analog circuitry may load down the ±15V supplies. Repair as required then resume at step 3.		
12	Check the +5V path to the Display PCB and the Display PCB Connector. Repair as required then resume at step 3.		
13	Check the strobes (U9-3, 4, 5, 6, 19) and display seven segment control lines (U9-8, 9, 10, 11, 12, 13, 14). Repair as required then resume at step.3.		
14	Set the RTD selector switch to the setting of the type RTD to be connected in the next step.		
15	Connect an RTD to the thermometer and measure some known temperature. (A lag bath is suggested.)		
16	Is the displayed temperature correct?	37	17
17	Check the RTD components and the ground sense buffer amp (U7, Q20 and their associated components). Repair as required then resume at step 14.		
18	Can the Calibration Adjustment Procedure be performed?	37	19
19	Are control signals at U9 pins 26, 27, 30, 31, 32 toggling between high and low logic levels? NOTE: the X100 signal at pin 33 of U9 will remain low (0V) unless unit is in 0.1° Range. (Use TP2 as common.)	21	20
20	Replace the microcomputer U9, then resume at step 14.		
21	Are the outputs of U13 toggling between high and low logic levels? NOTE: The output at pin 1 of U13 will remain low (0V) unless 2180 is in 0.1° Range.	23	22

Table 4-4. 2180A Troubleshooting (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
22	Check U13, Q27 and their associated components. Repair as required then resume at step 14.		
23	Is the waveform at TP7 as shown in Figure 4-4 (Magnitude & Polarity varies with the input signal)?	30	29
24	Is there 6.2 Vdc at TP16? (Use TP1 as common.)	26	25
25	Check the Reference Circuit providing an input at U4-3 from the divider R4, R5, R6, R7 and VR2. Repair as required then resume at step 14.		
26	Check from TP1 (analog ground) to U6-6 for 100 mV dc and for approximately 200 mV dc at U6-9.		
27	Are both voltages present?	29	28
28	Check Q8, Q9, Q10, Q11, Q12, Q13, Q14, Q15 and their associated components. Repair as required then resume at step 14.		
29	Check the RTD Input Module plus U5-1, Q19, Q21, Q22, and their associated components. Repair as required then resume at step 14.		
30	Is the waveform at U5-7 as shown in Figure 4-4 (Magnitude & Polarity varies with the input signal)?	34	31
31	Check the operation of Q5, Q6, Q7, Q18, U5 and their associated components. If any defective components are found, repair as required and resume at step 13. If none are found proceed to the next step.		
32	Connect TP2 and TP6 with a jumper to lock the instrument in the Auto Zero period.		
33	Check U5, U3, U2, Q4 and their associated components. This circuit should now function as a closed loop amplifier. Repair as required. Remove the jumper between TP2 and TP6 and resume at step 14.		
34	Does TP10 toggle between the high and low logic levels?	36	35
35	Check U1 and its associated components then resume at step 14.		
36	Replace the microcomputer U9, then resume at step 14.		
37	Troubleshooting of the 2180A is complete. Remove all test equipment, reconnect any cables removed and close the instrument.		



1 DE+ is generated for positive input voltages. Negative input voltages enable the DE− mode which, in turn, operates FET switch, Q13.

2 Waveform is shown for positive input voltage. It is inverted for negative inputs. Shown for full-scale in.

3 The Q numbers in parenthesis represent FET switches operated by the commands. See Figure 3-3.

Figure 4-4. Test Points and Measurement Cycle Waveforms

Table 4-5. Test Point Identification

TP1	Analog Common
TP2	Digital Common (−15V) (refer to Analog Common)
TP3	+15V (refer to Analog Common)
TP4	+5V (refer to Analog Common)
TP6	(U9-17) Trigger − S
TP7	Buffer Amp out (U5-1)
TP8	(U2-6)
TP9	Gain Stage out (U3-6)
TP10	Comparator out (U1-7) CM
TP11	△ 2 Settling Time Command
TP12	INT 1 Integrate Command
TP13	AZ Auto Zero Command
TP14	DE− Read Command (Negative Input)
TP15	DE+ Read Command (Positive Input)
TP16	6.2V (±100 uV)
TP17	6.2V (±100 uV)

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Section 5
List of Replaceable Parts

TABLE OF CONTENTS

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. A similar parts listing for each of the options will be found in Section 6. Components are listed alphanumerically by assembly. Both electrical and mechanical components are listed by reference designation. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation.

2. Description of each part.

3. FLUKE Stock Number.

4. Federal Supply Code for Manufacturers. (See Section 7 for Code-to-Name list.)

5. Manufacturer's Part Number.

6. Total Quantity per assembly or component.

7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

1. Quantity.

2. FLUKE Stock Number.

3. Description.

4. Reference Designation.

5. Printed Circuit Board Part Number.

6. Instrument Model and Serial Number.

* **Indicates MOS devices which may be damaged by static discharge.**

Table 5-1. 2180A Final Assembly
(See Figure 5-1.)

REFERENCE DESIGNATOR -A->-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	RS -Q	NOT -E-
A 1	*	MAIN PCB ASSEMBLY	469312	89536	469312	1		
A 2	*	DISPLAY PCB ASSEMBLY	489716	89536	489716	1		
A 3		RTD INPUT PCB ASSEMBLY	464305	89536	464305	1		
E 1		TERM,RING 3/32 & 1/8,SOLDR	151431	79963	329	1		
F 1		FUSE,1/4 X 1-1/4,SLOW,0.063A,250V	163030	71400	MDL1-16A		5	
F 1		FUSE,1/4 X 1-1/4,SLOW,0.125A,250V	166488	71400	MDL1-8A		1	
F 2		FUSE,1/4 X 1-1/4,SLOW,0.75A,250V	109256	71400	MDX3-4	1	5	
H 1		SCREW,THD FORM,PHP,STL,6-20X3/8	288266	89536	288266	1		
H 2		SCREW,MACH,PH,P,SS,4-40X.250	256156	89536	256156	3		
H 3		SCREW,MACH,PH,P,SS,4-40X.375	256164	89536	256164	2		
H 4		SCREW,MACH,FHP,BR,4-40X3/8	493932	89536	493932	1		
H 5		WASHER,LOCK,INTRNL,STEEL,0.512 ID	641381	89536	641381	2		
H 6		SCREW,MACH,FH,P,STL,6-32X0.625	114876	89536	114876	4		
MP 1		BASE-STANDARD	454702	89536	454702	1		
MP 2		GUARD,BASE	464404	89536	464404	1		
MP 3		REAR PANEL	464149	89536	464149	1		
MP 4		OUTPUT OPTION COVER	464412	89536	464412			
MP 5		LIMITS COVER	464156	89536	464156			
MP 6		LATCH	467548	89536	467548	2		
MP 7		BAIL	467555	89536	467555	1		
MP 8		FOOT,NONSKID	467571	89536	467571	4		
MP 9		FRONT PANEL WITH HARDWARE	655522	89536	655522	1		
MP 10		CALIBRATION COVER	471490	89536	471490	1		
MP 11		DECAL	454629	89536	454629	1		
MP 12		DECAL,BASE SIDES	473652	89536	473652	2		
MP 13		DECAL,REAR PANEL	454645	89536	454645	1		
MP 14		DECAL,BOTTOM	473637	89536	473637	1		
MP 15		CARD GUIDE	464164	89536	464164	2		
MP 16		"C" SIZE COVER ASSY	516708	89536	516708	1		
MP 17		HLDR PART,FUSE,CAP,1/4X1-1/4	460238	61935	031.1666	2		
TM 1		2180A INSTRUCTION MANUAL	489211	89536	489211	1	5	
U 9	*	IC,NMOS,8 BIT MICROCOMPUTR,2180A-9402	525659	89536	525659	1		
W 1		CABLE ASSY	475228	89536	475228	1		
W 2		CORD,LINE,5-15/IEC,3-18AWG,SVT	343723	89536	343723	1		
XF 1		HLDR PART,FUSE,BODY 1/4X1-1/4,5X20MM	375188	61935	031.1653	2		

An * in 'S' column indicates a static-sensitive part.

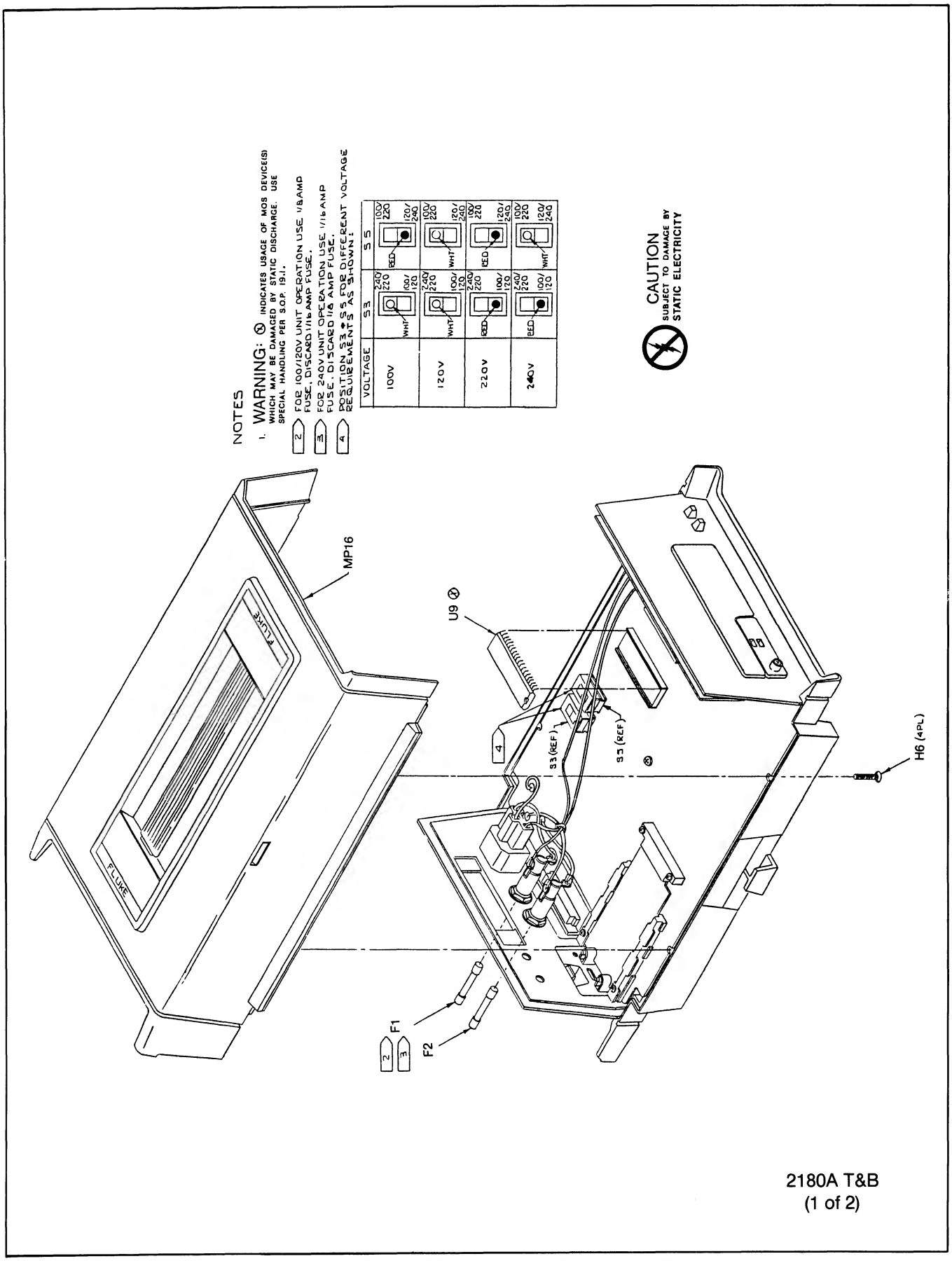


Figure 5-1. Final Assembly, 2180A Digital Thermometer

Table 5-3. A2 Display PCB Assembly
(See Figure 5-3.)

REFERENCE DESIGNATOR -A>-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	R S -Q	N O T -E-
DS 1- 7	*	LED,RED,7 SEGMENT, NUMERIC	418012	28480	5082-7651	7		
Q 1- 13	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	195974	64713	2N3906	13		
R 1		RES,CF,100,+-5%,0.25W	348771	80031	CR251-4-5P100E	1		
R 3		RES,CF,1,+-5%,0.25W	357665	80031	CR251-4-5P1E	1		
U 1	*	IC,ARRAY,5 TRANS,NPN,5 ISOLATED TRANS	418574	02735	CA3083E	1		
U 2		RES,NET,DIP,14 PIN,7 RES,1K,+-5%	407445	01121	314	1	1	
U 3		RES,NET,DIP,16 PIN,8 RES,82,+-5%	478859	89536	478859	1		

An * in 'S' column indicates a static-sensitive part.

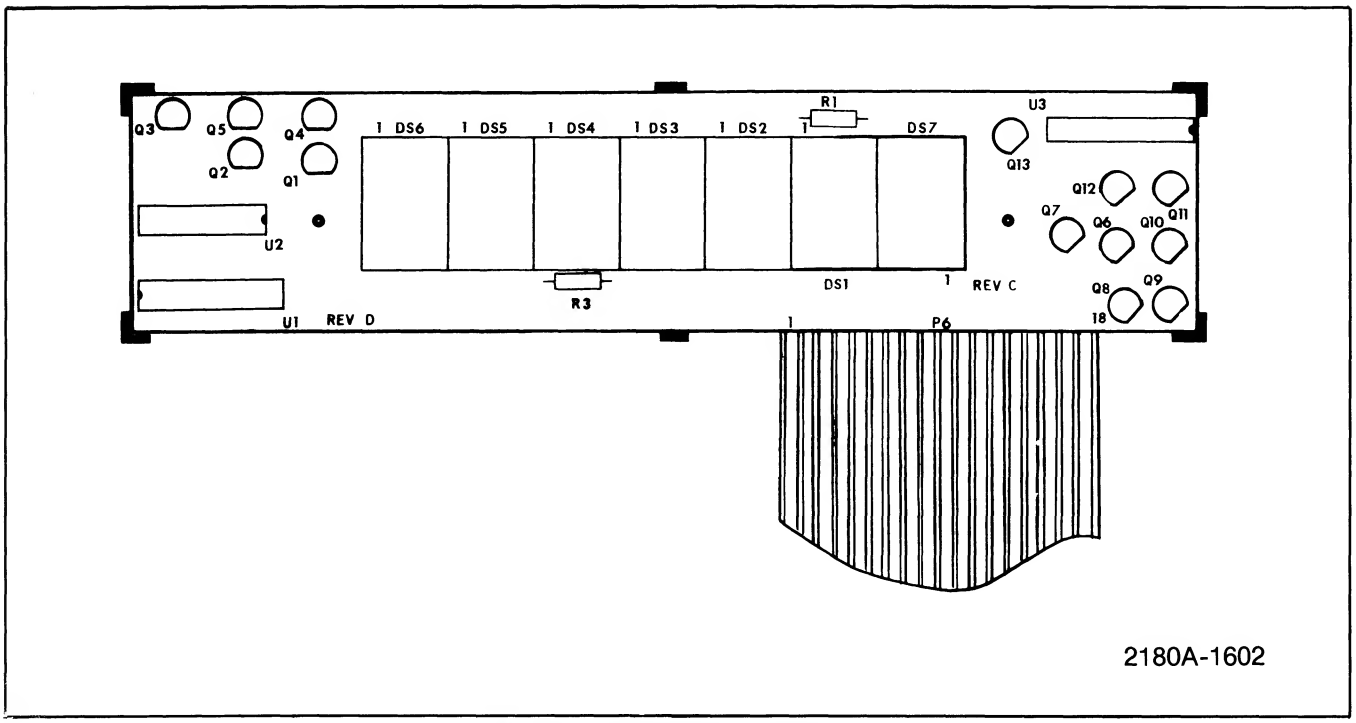


Figure 5-3. A2 Display PCB Assembly

Table 5-4. A3 RTD Input PCB Assembly
(See Figure 5-4.)

REFERENCE DESIGNATOR -A>-NUMERICS---->		S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	R S -Q	N O T -E-
C	1		CAP,POLYCA,2.2UF,+-10%,100V	306522	73445	C280MCH/A2M2	1		
H	1		NUT,PRESS,BROACH,STL,4-40	380196	24347	KF2-440	2		
H	1		SCREW,MACH,PH,P,SS,4-40X.437	403782	89536	403782	2		
H	2		WASHER,LOCK,SPLIT,STEEL,#4	110395	89536	110395	2		
H	3		WASHER,FLAT,FIBER,#4,0.031 THK	110890	89536	110890	2		
MP	1		INPUT DRAWER	464123	89536	464123	1		
R	1		RES,CC,47K,+-5%,1W	150219	01121	CB4735	1		
R	2		RES,VAR,CERM,500,+-20%,0.5W	267849	11236	190PC501B	1		
S	1		SWITCH,DIP,SPST,4 POS	408559	00779	435166-2	1		
S	2,3		SWITCH,PART,SLIDE,BOTTOM,DPDT	454777	10389	24-420-020	2		
S	2,3		SWITCH,PART,SLIDE,TOP,DPDT	454835	10389	24-420-020	2		
TB	1		TERM STRIP,PWB,45 ANG,0.200CTR,4 POS	461475	89536	461475	1		

An * in 'S' column indicates a static-sensitive part.

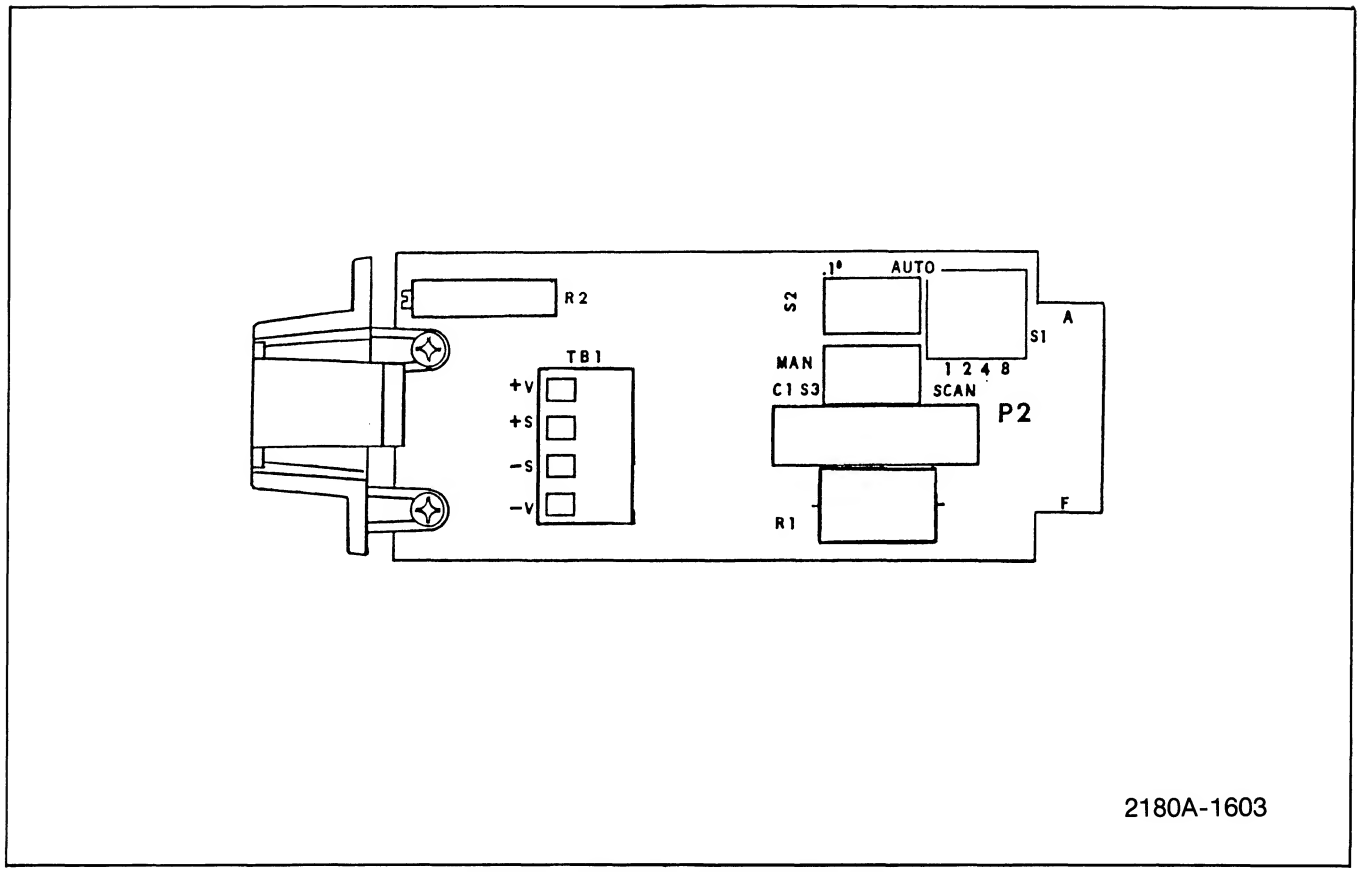


Figure 5-4. A3 RTD Input PCB Assembly

Section 6
Option & Accessory Information

TABLE OF CONTENTS

6-1. INTRODUCTION

6-2. This section of the manual contains information on the accessories and options available for the 2180A Digital Thermometer.

6-3. ACCESSORY INFORMATION

6-4. The portion of this section dealing with accessories contains the details of all accessories available for the 2180A.

6-5. OPTION INFORMATION

6-6. Each of the options available for the 2180A are described separately in a subsection identified with the option name and number. The option description contains the information on the operating instructions and maintenance not covered in the main body of the text, plus a complete list of replaceable parts for the option.

Accessories

600-1. GENERAL

600-2. Table 600-1 contains a list of the accessories available for use with the 2180A Digital Thermometer. The following paragraphs contain information on the types of accessories. Instructions for use accompany each accessory. In all cases order using the accessory number listed.

600-3. RTD MULTIPOINT SELECTOR, (Y2000)

600-4. The Multipoint Selector allows the operator to manually select and monitor the one of up to ten channels; two separate thermocouple types (maximum of five each if two types used) may be connected to the unit. Up to ten multipoint selectors may be connected in series.

600-5. BATTERY PACK, 12V RECHARGEABLE (Y2009)

600-6. The rechargeable battery pack provides the 2180A and its accessories with portability. The output is +12V dc at a maximum of 750 mA for a total of 2.2 ampere-hours.

Table 600-1. 2180A Accessories

ACCESSORY	DESCRIPTION
Y2000	Multipoint Selector, RTD
Y2009	Battery Pack, 12V Rechargeable
Y2010	Rack Panel PTI, single, A size (for Y2000)
Y2014	Rack Panel PTI, single, C size (for 2180A and Y2002)
Y2015	Rack Panel PTI, double, C size (for 2180A and Y2002)
Y2016	7-inch Rack Adapter PTI, single, D size
Y2017	7-inch Rack Adapter PTI, double, D size
Y2020	Panel Mount PTI-DIN, C size (for 2180A and Y2002)
Y2021	145 mm Panel Mount PTI, D size
Y2022	Divider, Thermometer Calibrator
Y2024	Power Cord, 3-way
Y2026B	Cable, Output Unit, RS-232-C
Y2031	Input Module (for 2180A)
Y2035	Thermal Paper (box of 10)
Y2037	Pt 390 RTD Probe
Y2039	Pt 392 Probe

600-7. DIVIDER, THERMOMETER CALIBRATION (Y2022)

600-8. The device is a preset 100 to 1 divider to provide the precision millivolt outputs from a DC Calibrator required for calibration. The device wires into the RTD Input PCB in place of the RTD Probe during calibration. Refer to the Y2022 Instruction manual for the schematic and additional information.

600-9. RACK PANELS

600-10. Available are rack mounting panels in three sizes and two types for the standard 19-inch electronics equipment racks. The "A" size for the Multipoint Selector is available in panels that will accomodate either one or two instruments. The "B" size panel for the Calibrator and/or Battery Pack is also available for single or double instruments, as is the "C" size used for the 2180A Thermometer and the Alarms Output.

600-11. PANEL MOUNTS

600-12. The panel mounts provide the hardware to install the instrument in any panel in which a hole the size of the instrument front panel can be cut. It is available for the three instrument sizes required, "A", "B", and "C".

600-13. POWER CORD, 3-WAY (Y2024)

600-14. This accessory is a specially constructed power cord with three female and one male connectors that allow the operator to connect up to "C" size or smaller PTI instruments with one line power cord.

600-15. CABLE OUTPUT UNITS, RS232C (Y2026B)

600-16. The Y2026B is an interface device which allows direct mating between any RS232C device and the -002 Output Option. The Y2026B consists of two 25-pin connectors, one 36-pin connector, and an accessory cable to connection between the 36-pin output and the -002 Output Option. It will be necessary for the user to provide the cable between the 25-pin outputs and the RS232C devices.

Option -002
Output

602-1. INTRODUCTION

602-2. The 21X0-002 Option is an analog and digital output unit. It provides either the 2180A or 2190A Model Digital Thermometers with a recording output for a permanent record when required. The option may be ordered with the unit for factory installation or is available as a kit for installation in the field.

602-3. The analog output is available on the rear panel at two flush banana jacks with the polarity indicated. The output is a scaled voltage source of 1 millivolt per degree of temperature, regardless of the temperature scale selected, with the polarity as read on the display. For example; a reading of 251°F would output +251 mV dc; 97.3°C would output +97.3 mV dc; and -31.9°F would output -31.9 mV dc.

602-4. The digital output is a clocked message that can be in two different formats to match the requirement of the customer's equipment. Output on one set of lines is a bit-parallel, byte-serial message format designed for printer interface. Also available are the standard EIA RS232C and current loop bit-serial outputs. Both formats provide the channel number, the current reading displayed, and any out of range or open thermocouple information.

Table 602-1. Specifications

Analog Output
Type: Linearized and isolated.
Voltage: 1.0 mV/ °C or °F from –425 mV to 4.5V, 5 mA max.
Temperature Coefficient: 200 ppm/ °C from 25°C.
Noise: ≤100 uV at 100 Hz bandwidth.
Accuracy: ±0.1% of reading ±1 mV.
Zero Drift: 200 uV/°C from 25°C,
Warm-Up Time: 5 minutes, to rated accuracy.
Digital Output
Types: Three, E.I.A. Standard RS-232-C Type 2, TTY current loop, and parallel ASCII.
Connector: 36-pin AMP "Champ".
Serial Baud Rates: 110, 150, 300, 600, 1200, 2400, 4800, 9600, switch-selectable.
RS-232-C Signals: Transmitted Data, Request to Send, Clear to Send, Data Set Ready, Signal Common.
Parallel ASCII Signals: Data 8 lines, instrument address 3 lines, Address Valid, Data Valid, Acknowledge, ground, +5V.
Parallel ASCII Data Rate: Three readings per second.
Parallel ASCII Interface: Plug-to-plug compatible with similar Fluke equipment. CMOS compatible, drives one TTL load.
TTY Current Loop Signals: Source and controlled sink, 20 mA.
Out-of-Limit Signal: Exclamation point transmitted with Option 21X0-006 only; not with Y2002.
Battery Operation: 4 to 5 hours typical at 25°C on fully charged Y2003 or Y2009.

602-5. SPECIFICATIONS

602-6. Specifications for the Output Option, 21X0-002, are as listed in Table 602-1.

602-7. INSTALLATION

602-8. Options for field installation can be installed using the following procedure:

1. Disconnect the thermometer from all input power sources.

2. Remove the screws on the bottom of the case that fasten the top and bottom of the PTI case together and remove the top half of the case.

3. Remove the center mounting screw that attaches the Main PCB to the case and lift the pcb clear of the case.

4. Attach the four spacers supplied with the option to the component side of the pcb in the holes forming a rough rectangular pattern (do not use the fifth hole on the corner, next to U1).

Table 602-2. Switch Selection

SWITCH POSITION	SWITCH BANK				S1 BAUD RATE	S2 FUNCTION	S3 ADDRESS
	1	2	3	4			
0	OFF	OFF	OFF	OFF	110	OPERATE	ADR 0
1	ON	OFF	OFF	OFF	150	CAL 1	ADR 1
2	OFF	ON	OFF	OFF	300	CAL 2	ADR 2
3	ON	ON	OFF	OFF	600	CAL 3	ADR 3
4	OFF	OFF	ON	OFF	1200	CAL 4	ADR 4
5	ON	OFF	ON	OFF	2400	CAL 1	ADR 5
6	OFF	ON	ON	OFF	4800	CAL 2	ADR 6
7	ON	ON	ON	OFF	9600	CAL 3	ADR 7
8	OFF	OFF	OFF	ON	110	PLOT 1	ADR 8
9	ON	OFF	OFF	ON	150	PLOT 2	ADR 9

5. Reinstall the Main PCB in the bottom half of the case.

6. On the Output Unit PCB use Table 602-2 and S1 to select the desired BAUD rate, select position 0 on the Function switch S2, and select the PTI Bus Address using S3. When using the RS-232-C interface, set the address switch S3 to address 1, 6, 7, 8, or 9. When using the 2XXXA-522 Personality Card and the 1120A IEEE-488 Translator, set the baud rate to 2400 and follow all procedures regarding the RS-232-C interface.

7. Connect the Output Unit cables to the connectors on the Main PCB.

8. Attach the Output Unit PCB to the spacers, component side down, and the connector to the rear panel access port.

9. Replace the PTI cover on the instrument and reconnect the input power sources, if required, at this time.

Table 602-3. Digital Output Connector Pin-Out

PIN NO.	FUNCTION	MNEMONIC	USE
1	Address Valid	ADRVAL	PTI Bus
2	Data Valid	DATVAL	PTI Bus
3-6	Printer Address	A0-A3	PTI Bus
7	Acknowledge	ACK	PTI Bus
8	Not Used		
9-16	Data	D0-D7	PTI Bus
17	Ground		PTI Bus
18	+5 Volts		PTI Bus
19-24	Not Used		
30	Transmitted Data		RS232 Interface
31	Request to send		RS232 Interface
32	Clear to send		RS232 Interface
33	Data set ready		RS232 Interface
34	Signal Common		RS232 Interface
35	S0+		Current Loop
36	S0–		Current Loop

602-9. OUTPUT CONNECTIONS

602-10. All connections between the Output Unit Option and external instruments are made using the rear panel connectors previously described. The analog output is from standard banana jacks. The digital output female connector has a mating male connector accompanying the option. This allows the customer to custom make a cable between the thermometer output option and the receiving device. Table 602-3, is the pin-out data for the digital output connector.

NOTE

Standard RS232C signals are output on 25-pins, the connector on the -002 Output Option is 36-pins, therefore, the user must either hardwire the connection between the -002 Output Option or order the Y2026B, Cable Adapter.

602-11. OPERATION

NOTE

For RS232C or 20 mA current loop operation, the -002 address switches may be ignored.

The Data Set Ready (DSR, pin 33) or Clear To Send (CTS, pin 32) must be at +3 V to +15 V in order to output data on the RS232C bus. These lines can be tied to Request To Send (RTS), pin 31) which provides the required +15 V.

602-12. Once the Output Unit Option is installed, the only operator functions deal with the connection of external equipment to the analog or digital output connectors.

602-13. The positive and negative analog terminals have available a dc millivolt output with the same polarity, and proportional to the temperature displayed. For example, if the thermometer displayed +105.7° F the analog output would be +105.7 mV dc and for –53.1°C the output would be –53.1 mV dc. The full resolution of the temperature display (tenths or hundredths of degrees) is reflected on the output.

602-14. The digital output can be connected to a printer or any device accepting parallel ASCII data, or to a device accepting RS232C or Current Loop signals. Connections for all three types of signals are available simultaneously on the 36-pin output connector previously described.

602-15. THEORY OF OPERATION

602-16. The Output Unit Option converts the temperature displayed by the output into a format usable by the customer's equipment. The output may be available as a scaled analog voltage or as formatted parallel and serial ASCII digital output. The following paragraphs describe operation of the Accessory Bus that handles communication between the instrument and the options, the analog output circuitry and the digital output circuitry. Refer to the schematic in Section 8 during the following discussion.

602-17. Accessory Bus Communication

602-18. The option communicates with the thermometer on the clocked bit-serial accessory bus. Transmitted on the bus are channel number, range, conversion type, scale, and digits of the temperature reading. When the WRTADR line is held low, DCLK clocks the address of the Output Unit (4), followed by the thermometer data to the microprocessor on the DATA line. Once into the microprocessor, the data is converted, formatted, and output to the analog and digital output circuitry.

602-19. Analog Circuitry

602-20. The temperature reading received by the microcomputer is used to generate an integrate control signal, the length of which is proportional to the magnitude of the temperature reading. This signal is used to turn on (close) the FET switches Q6 and U12-2, open the switches U11-2, U11-3 and U12-3, and set the output polarity with switches at U12-9 and U12-10. (U12-9 is closed when a negative reading is being processed and U12-10 when a positive signal is being processed.)

602-21. With Q6 on, the capacitor C1 is charged linearly to a voltage proportional to the length of the control signal at Q6. When Q6 has been on for the time required, it is opened, and switch U11-13 is closed, so the output of U13-8 can be sampled and held on C2. After 10 ms switch U11-3 opens and switch U11-11 closes to zero the integrate capacitor C1, until the next conversion cycle.

602-22. The voltage held on C2 is buffered by U13-7. U13-14 either passes the voltage directly to the output stage, or amplifies it as controlled by switches U12-9 and U12-10, which alternate states to set the polarity. The output stage at U13-1 has a constant gain of –1.

602-23. Digital Output Circuitry

602-24. The thermometer reading transmitted on the accessory bus every 333 ms is formatted by the microcomputer and, if requested, made available on the PTI Bus, RS232C, and current loop outputs. Refer to the schematics in Section 8 during the following description.

602-25. Eight data, four address, a data valid, an address valid, and an acknowledge line are used by the PTI Bus Interface. The external device requests data from the Output Unit by applying the preselected address to the address lines. The address is preselected by setting switch S3 to the desired number (0-9). When the proper address is decoded the tri-state output buffers (U8 and U9) are enabled, and the microcomputer and external device are notified that the Output Unit has a valid address. When the conversion process is complete, the microcomputer applies the first character of the formatted data to the output lines and pulls the DATVAL line low. The external device reads the data and pulls the ACK line low, causing the Output Unit to reply with a new character. The process is repeated until data transfer is complete. The message formats are shown in Figure 602-1, and a timing diagram is shown in Figure 602-2.

602-26. After transfer to the printer lines is complete, the microcomputer checks the DATA SET READY and CLEAR TO SEND lines from the RS232C Interface. If both lines are high, the same message as was output on the print lines is output on the RS232C and current loop lines in a bit-serial format. Since the thermometer cycle rate of 333 ms is shorter than the time required to output data at BAUD rate of 1200 and less, a message is not transmitted during every instrument cycle.

602-27. CALIBRATION

602-28. Analog circuitry in the option should be calibrated every 90 days or after any repair of the unit. The procedure following assumes that power is supplied to the unit and that a Digital Voltmeter capable of reading 10 μV on the 1 volt, or equivalent range, i.e., a Fluke Model 8800A, is available.

1. Remove power from the instrument.

2. Remove the top cover from the thermometer.

3. Remove the screws attaching the option pcb to the Main PCB.

4. Leaving the interconnect cables connected, turn the option pcb to the right, while facing the instrument, exposing the component side and making the switches and adjustment accessible.

5. Connect the DMM to the Analog Output Connector.

6. Apply power to the instrument and allow if to warm-up for a minimum of 5 minutes.

7. Set the FUNCTION switch (S2) to position 1 (CAL 1).

8. Adjust R26 for an output of 0 $\pm$ 0.1 mV dc.

9. Set the FUNCTION switch to position 2 (CAL 2).

10. Adjust R15 for an output of 0 $\pm$ 0.1 mV dc.

11. Set FUNCTION switch to position 3 (CAL 3).

12. Adjust R11 for an output of -10V $\pm$ 1 mV dc.

13. Set FUNCTION switch to position 4 (CAL 4).

14. Adjust R19 for an output of +10V $\pm$ 1 mV dc.

15. Remove power and the test DMM, then reinstall the option pcb on the Main PCB and the top cover on the instrument.

602-29. TROUBLESHOOTING

602-30. Troubleshooting for the 2180A Option -002, Output Unit, consists of the tabular flow chart in Table 602-4. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

602-31. LIST OF REPLACEABLE PARTS

602-32. Table 602-5 is a list of replaceable parts for the Output Option. Refer to Section 5 for an explanation of the columnar entries.

CHARACTER POSITION

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

NORMAL TEMPERATURE MEASUREMENT DATA

CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	SP	F/C	SP	!	SP	SP	CR	LF

OPEN THERMOCOUPLE OUTPUT (2190A only)

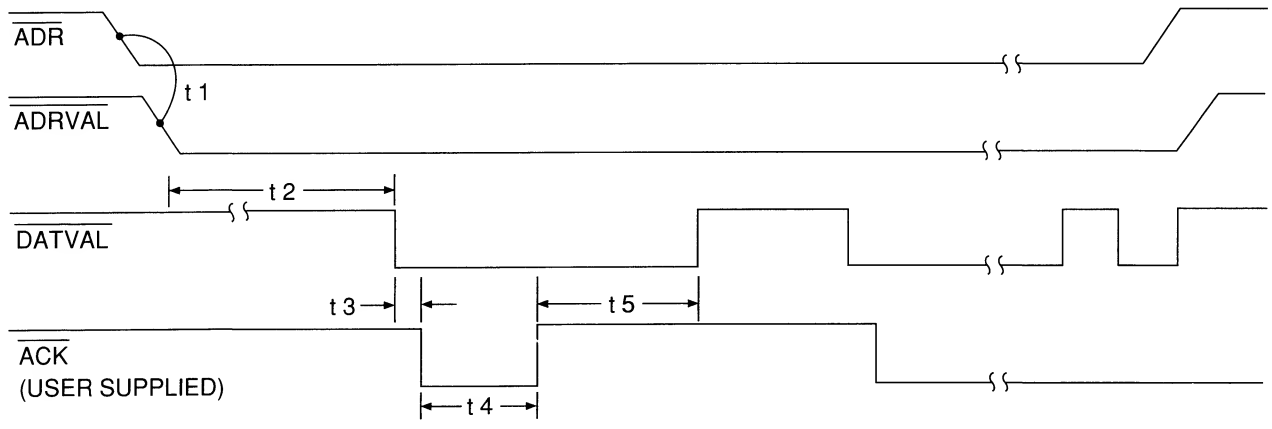
CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	SP	F/C	SP	!	O	C	CR	LF

OVERLOAD OUTPUT

CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	SP	F/C	SP	!	O	L	CR	LF

SYMBOL	DESCRIPTION
CH	Channel identification numbers (00 through 99, 00 unless connected to Y2000, Y2001, or 2300A).
SP	Space
+/-	Plus or minus symbol
D	Temperature data values (0 through 9) Floating decimal point, appearing in character positions 11 or 12 for the 2180A, position 12 for the 2190A.
D/.	Either a temperature data value or a decimal point
F/C	Fahrenheit or Celsius
!	Character (!) when the present limit of the Limits Option 21X0A-006 is exceeded. One space if within limits.
OC	Open (thermo)couple (character positions 18 and 19)
OL	Overload (character positions 18 and 19)
CR	Carriage Return
LF	Line Feed

Figure 602-1. Message Format



t1 1 µS max.
t2 20 µS tp 300 mS, depending upon reading cycle.
t3 0 µS min.
t4 20 µS min.
t5 20 µS typical.

Figure 602-2. Timing Diagram

Table 602-5. Option -002 Output PCB Assembly
(See Figure 602-3.)

REFERENCE DESIGNATOR -A>-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	R S -Q	NOT E-
A 1	*	OUTPUT UNIT ADAPTER ASSEMBLY	539288	89536	539288	1		
C 1		CAP,POLYPR,0.47UF,+-5%,100V	806265	89536	806265	1		
C 2		CAP,POLYPR,0.47UF,+-10%,50V	363085	89536	363085	1		
C 3		CAP,CER,0.22UF,+-20%,50V,Z5U	309849	71590	CW3COC224K	1		
C 4, 6, 9-		CAP,TA,10UF,+-20%,20V	330662	56289	196D106X0020KA1	8		
C 11, 13- 15			330662					
C 5		CAP,TA,39UF,+-20%,20V	358234	56289	196D396X0020PE4	1		
C 7, 8		CAP,TA,22UF,+-20%,35V	394775	56289	196D226X0035TE4	2		
C 12, 16		CAP,TA,1UF,+-10%,35V	161919	56289	196D010X0035G	2	1	
C 17		CAP,CER,0.025UF,+-20%,100V,Z5W	168435	56289	CO23B101H253M	1	1	
CR 3- 6, 11-	*	DIODE,SI,BV=75V,IO=150MA,500MW	203323	07910	1N4448	10	1	
CR 14, 16, 17	*		203323					
CR 9, 10	*	DIODE,SI,50 PIV,1.0 AMP	379412	04713	1N4933	2	1	
H 1		HARDWARE KIT (FOR J7)	435750	89536	435750	1		
H 2		WASHER,LOCK,SPLIT,STEEL,#4	110395	89536	110395	2		
H 3		NUT,HEX,S.STL,4-40	147611	89536	147611	2		
H 4		SCREW,MACH,PH,P,4-40X0.375	837690	89536	837690	2		
J 7		CONN,MICRO-RIBBON,REC,PWB EDGE,36 POS	414409	00779	552241-1	1		
J 8		INPUT JACK,FLARED	492314	89536	492314	2		
P 1		CABLE,FLAT,JMPR,4 CONDUCT,0.100 SP	474148	89536	474148	1		
P 3		CABLE,FLAT,JMPR,6 CONDUCT,0.100 SP	474155	00779	86942-5	1		
Q 2, 4, 5,	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	04713	2N3904	6		
Q 8, 9, 13	*		218396					
Q 6	*	TRANSISTOR,SI,N-JFET,REMOTE CUTOFF	429977	89536	429977	1	1	
Q 7	*	TRANSISTOR,SI,N-JFET,TO-92	343830	12040	NSSF50024	1	1	
Q 10, 11	*	TRANSISTOR,SI,BV= 80V, 10W,TO-202	495697	04713	MPS-U06	2	1	
Q 12	*	TRANSISTOR,SI,BV= 40V, 2W,TO-220	473207	01295	TIP30	1		
Q 14	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	195974	64713	2N3906	1		
R 1- 3, 27-		RES,CF,10K,+-5%,0.25W	348839	80031	CR251-4-5P10K	12		
R 30, 32- 34,			348839					
R 48, 50			348839					
R 4, 6, 8		RES,CF,220K,+-5%,0.25W	348953	80031	CR251-4-5P220K	3		
R 5, 7, 9,		RES,CF,2.2K,+-5%,0.25W	343400	80031	CR251-4-5P2K2	4		
R 31			343400					
R 10		RES,MF,16.9K,+-1%,0.125W,100PPM	267146	91637	CMF551692F	1		
R 11		RES,VAR,CERM,25K,+-20%,0.5W	285213	11236	190PC253B	1		
R 12		RES,MF,124K,+-1%,0.125W,25PPM	479352	91637	CMF55	1		
R 13		RES,MF,2K,+-1%,0.125W,100PPM	235226	91637	CMF552001F	1		
R 14		RES,MF,750K,+-1%,0.125W,100PPM	271361	89536	271361	1	1	
R 15, 26		RES,VAR,CERM,100K,+-20%,0.5W	268581	71450	190PC104B	2		
R 16, 17		RES,MF,60.4K,+-1%,0.125W,100PPM	291419	91637	CMF556042F	2		
R 18, 20		RES,MF,3.92K,+-1%,0.125W,100PPM	294801	91637	CMF553921F	2		
R 19		RES,VAR,CERM,100,+-10%,0.5W	285130	89536	285130	1		
R 21, 22, 45		RES,MF,10K,+-1%,0.125W,100PPM	168260	91637	CMF551002F	3		
R 23, 47		RES,CF,100,+-5%,0.25W	348771	80031	CR251-4-5P100E	2		
R 24		RES,MF,1M,+-1%,0.125W,100PPM	268797	91637	CMF551004F	1		
R 25		RES,MF,1K,+-1%,0.125W,100PPM	168229	91637	CMF551001F	1		
R 35		RES,CF,5.1K,+-5%,0.25W	368712	80031	CR251-4-5P5K1	1		
R 36		RES,CF,47K,+-5%,0.25W	348896	80031	CR251-4-5P47K	1		
R 37		RES,CF,240,+-5%,0.25W	376624	80031	CR251-4-5P240E	1		
R 38		RES,CF,3.9K,+-5%,0.25W	342600	80031	CR251-4-5P3K9	1		
R 39, 41		RES,CF,6.8K,+-5%,0.25W	368761	80031	CR251-4-5P6K8	2		
R 40		RES,CF,4.3K,+-5%,0.25W	441576	80031	CR251-4-5P4K3	1		
R 42		RES,CF,3.3K,+-5%,0.25W	348813	80031	CR251-4-5P3K3	1		
R 43		RES,CF,330,+-5%,0.25W	368720	80031	CR251-4-5P330E	1		
R 44		RES,MF,1.02K,+-1%,0.125W,100PPM	223545	91637	CMF551021F	1		
R 46		RES,MF,9.09K,+-1%,0.125W,100PPM	221663	91637	CMF559091F	1		
R 49		RES,MF,4.32K,+-1%,0.125W,100PPM	294819	91637	CMF554321F	1		
R 51		RES,CF,39K,+-5%,0.25W	442400	80031	CR251-4-5P39K	1		
R 52		RES,MF,100K,+-1%,0.125W,100PPM	248807	91637	CMF551003F	1		
R 53		RES,MF,64.9K,+-1%,0.125W,100PPM	288530	91637	CMF556493F	1	2	
R 54		RES,MF,226K,+-1%,0.125W,100PPM	320879	91637	CMF552263F	1		
R 55		RES,MF,309K,+-1%,0.125W,100PPM	235283	91637	CMF553093F	1		
S 1- 3		SWITCH,DIP,SPST,4 POS	408559	00779	435166-2	3		
T 1		TRANSF,INV,MULTIPLE OUTPUT,TOROID	461954	89536	461954	1		
U 1	*	IC,CMOS,HEX BUFFER	381830	02735	CD4050AE	1	1	
U 2- 4	*	ISOLATOR,OPTO,LED TO TRNSISTOR	536045	14936	MCT-26	3	1	
U 5		RES,NET,SIP,8 PIN,7 RES,47K,+-2%	413286	89536	413286	1		
U 6	*	IC,CMOS,HEX OPEN DRAIN BUFFER	473389	12040	MM74C906N	1	1	

An * in 'S' column indicates a static-sensitive part.

Table 602-5. Option -002 Output PCB Assembly (cont)

REFERENCE DESIGNATOR -A->-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	R S -Q	N O T -E-
U 7	*	IC,NMOS,8 BIT MICROCOMPUTR,2190A-9403	495309	89536	495309	1		
U 8, 9	*	IC,CMOS,HEX BUFFER W/3-STATE OUTPUT	407759	12040	MM80C97N	2	1	
U 10	*	IC,CMOS,HEX INVERTER	404681	02735	CD4069BE	1	1	
U 11, 12	*	IC,CMOS,QUAD BILATERAL SWITCH	363838	02735	CD4016AE	2	1	
U 13	*	IC,OP AMP,QUAD,JFET INPUT,14 PIN DIP	483438	89536	483438	1	1	
U 14	*	TRANSISTOR,SI,N-JFET,DUAL,TO-71	419283	89536	419283	1	1	
U 15, 21		RES,NET,SIP,6 PIN,5 RES,100K,+-2%	412726	89536	412726	2		
U 16	*	IC,CMOS,QUAD XOR GATE	355222	02735	CD4030AE	1	1	
U 17	*	IC,CMOS,DUAL 4 INPUT NOR GATE	363820	02735	CD4002AE	1	1	
U 18	*	IC,OP AMP,DUAL,JFET INPUT,8 PIN DIP	454454	02735	CA082E	1	1	
U 19	*	IC,VOLT REG,FIXED,+15 VOLTS,1.5 AMPS	413187	04713	MC7815CT	1	1	
U 20	*	IC,VOLT REG,FIXED,-15 VOLTS,1.5 AMPS	413179	04713	MC7915CP	1	1	
U 22	*	IC,COMPARATOR,DUAL,LO-PWR,8 PIN DIP	478354	12040	LM393N	1	1	
VR 1	*	ZENER,COMP, 6.4V, 2%, 2 PPM TC, 0.5MA	393579	04713	1N4567	1		
VR 7, 8	*	ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	186163	04713	1N974B	2	2	
VR 15	*	ZENER,UNCOMP,6.2V,5%,20.0MA,0.4W	325811	07910	1N753A	1	1	
X 1		SOCKET,IC,40 PIN	429282	09922	DILB40P-108	1		
Y 1	*	CRYSTAL,4MHZ,+-0.02%,HC-18/U	474072	89536	474072	1	1	

An * in 'S' column indicates a static-sensitive part.

Table 602-6. A1 Output Unit Adapter PCB Assembly
(See Figure 602-4.)

REFERENCE DESIGNATOR -A->-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	R S -Q	N O T -E-
J 1- 6		PIN,SINGLE,PWB,0.025 SQ	376574	89536	376574	6		
Q 1, 3	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	89536	218396	2		
R 1		RES,CF,10K,+-5%,0.25W	348839	89536	348839	1		
U 1	*	IC,CMOS,DUAL D F/F,+EDG TRIG	340117	89536	340117	1		
U 2	*	IC,CMOS,HEX INVERTER	404681	89536	404681	1		

An * in 'S' column indicates a static-sensitive part.

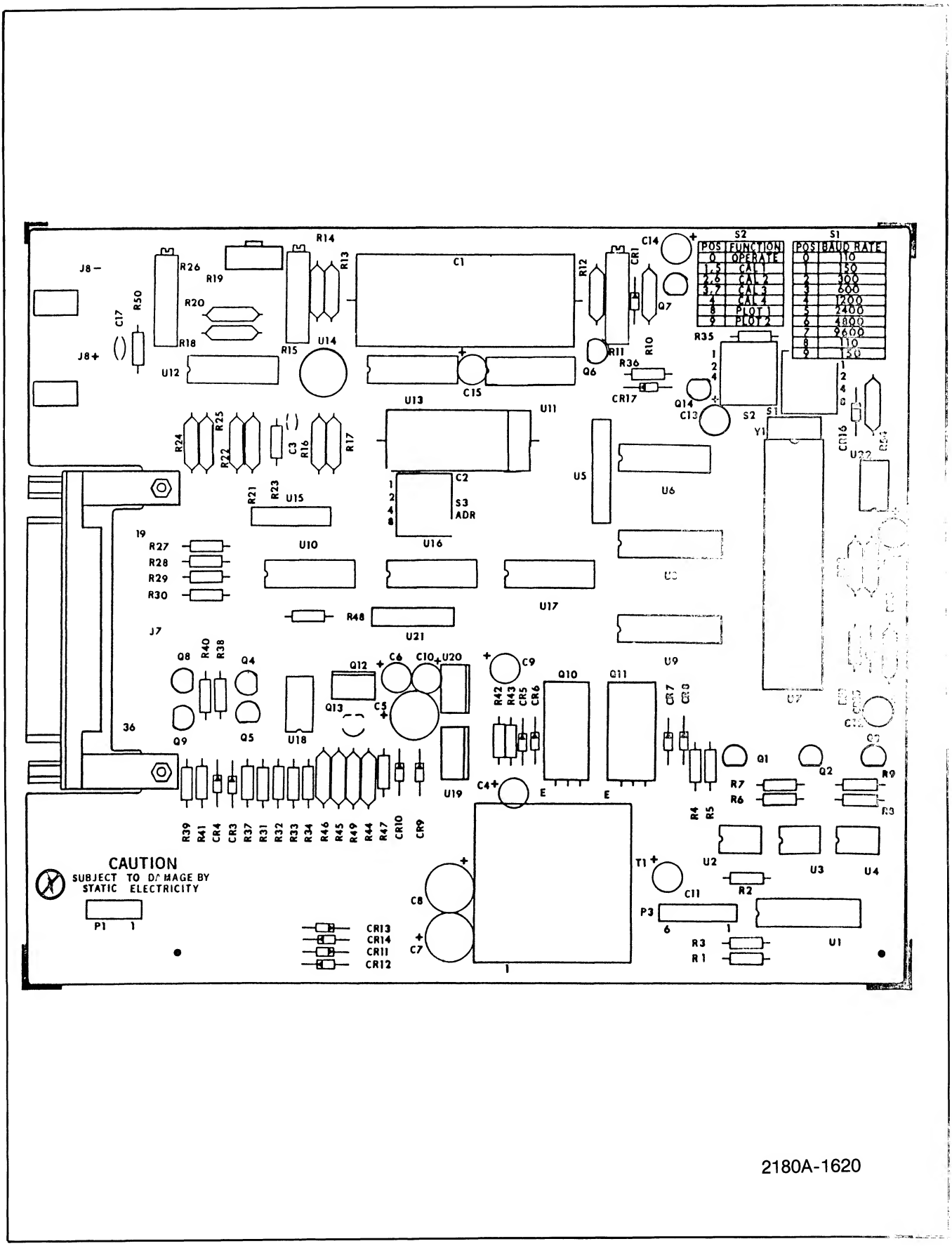
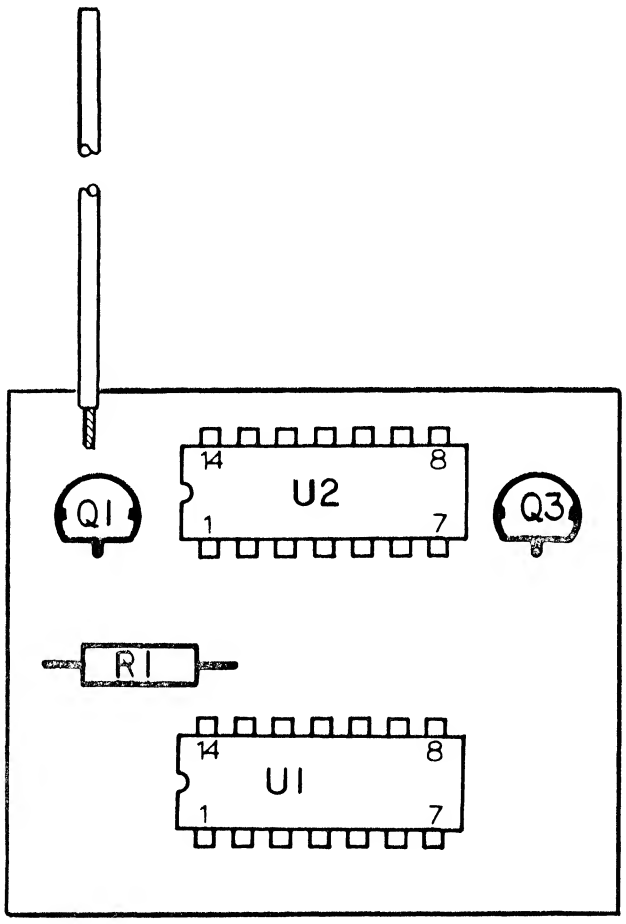


Figure 602-3. Option -002 Output PCB Assembly



2180A-1621

Figure 602-4. Output Unit Adapter Assembly

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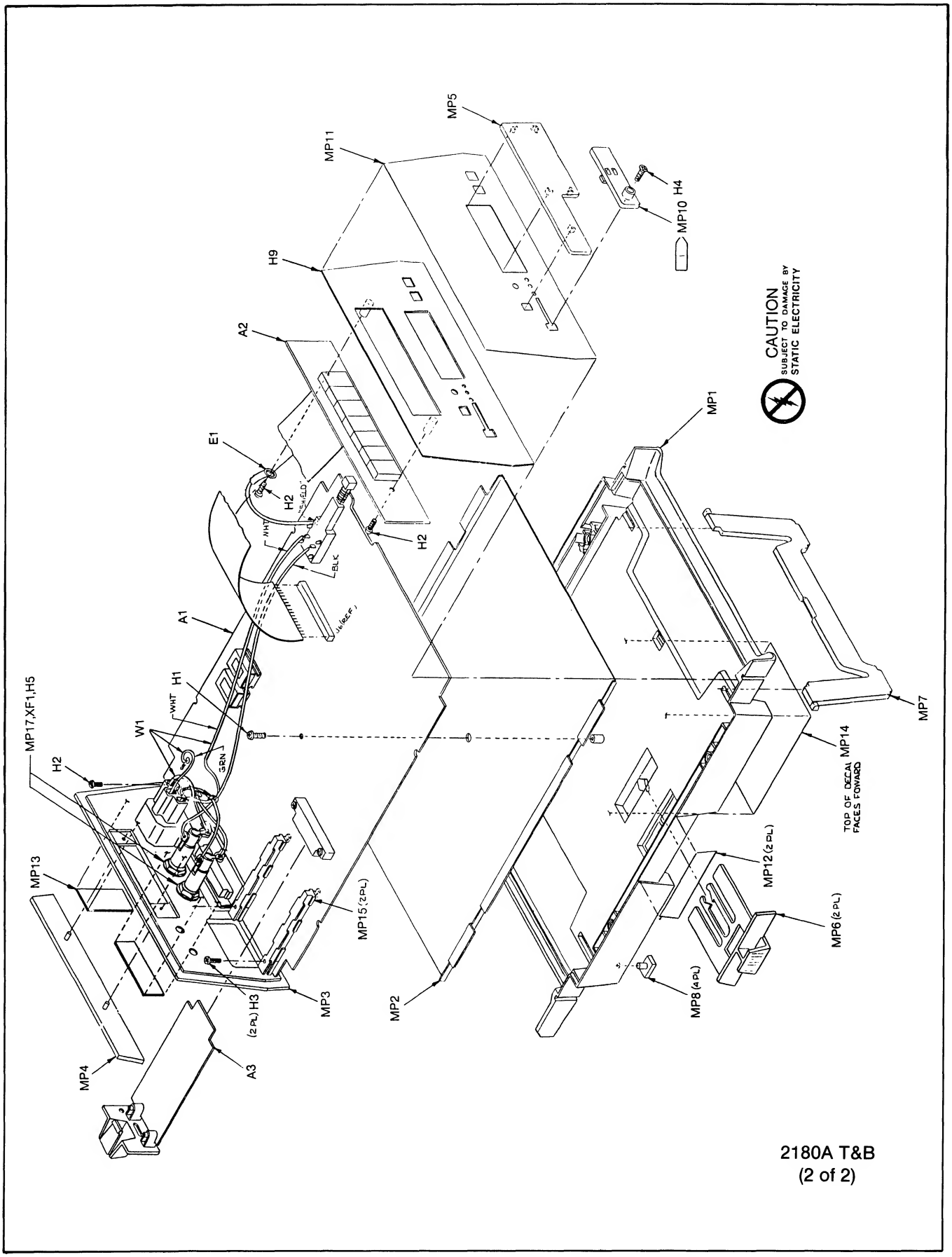


Figure 5-1. Final Assembly, 2180A Digital Thermometer (cont)

Table 5-2. A1 Main PCB Assembly
(See Figure 5-2.)

REFERENCE DESIGNATOR -A>-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	R S -Q	N O T -E-
C 1, 3, 4,		CAP,TA,10UF,+-20%,20V	330662	56289	196D106X0020KA1	16		
C 6, 8- 11,			330662					
C 15, 16, 23,			330662					
C 24, 29, 32,			330662					
C 33, 35			330662					
C 2		CAP,POLYPR,0.47UF,+-5%,50V,HERMETIC	364042	84411	JF788	1		
C 5		CAP,CER,0.0012UF,+-10%,500V,Z5R	106732	71590	CF122	1		
C 12		CAP,POLYCA,2.2UF,+-10%,100V	306522	73445	C280MCH/A2M2	1		
C 13, 14, 17,		CAP,MICA,430PF,+-5%,500V	177980	14655	CD15FD431J0	6		
C 18, 21, 22			177980					
C 19, 20		CAP,TA,10UF,+-20%,35V	417683	56289	196D106X[illegible]35KA1	2		
C 25		CAP,MICA,5PF,+-0.5PF,500V	148577	89536	148577	1		
C 26		CAP,AL,4700UF,+75-20%,25V	614115	89536	614115	1		
C 28		CAP,TA,39UF,+-20%,20V	358234	56289	196D396X0020PE4	1		
C 30, 31		CAP,TA,22UF,+-20%,35V	394775	56289	196D226X0035TE4	2	1	
C 36		CAP,TA,1UF,+-10%,35V	161919	56289	196D010X0035G	1		
CR 1, 2, 4,	*	DIODE,SI,BV=75V,IO=150MA,500MW	203323	07910	1N4448	10	1	
CR 5, 9- 12,	*		203323					
CR 17, 19	*		203323					
CR 3	*	DIODE,SI,RECT,BRIDGE,BV=100V,IO=1.0A	392910	09423	FB200	1	1	
CR 6, 7	*	DIODE,SI,50 PIV,1.0 AMP	379412	04713	1N4933	2		
CR 8, 14, 15	*	DIODE,SI,N-JFET,CURRENT REG,IF=1.0 MA	348482	89536	348482	3	1	
CR 13	*	DIODE,SI,100 PIV,1.5 AMP	116111	05277	1N4817	1	2	
CR 16	*	DIODE,SI,2 PELLET,BV= 20.0V,400 MW	375477	09214	MPD200	1	1	
H 2		INSERT,STUD,BROACHING,PHOSPHOR BRONZE	493833	89536	493833	4		
H 3		SCREW,MACH,PH,P,,4-40X0.375	837690	89536	837690	2		
H 4		WASHER,FLAT,BRASS,#4,0.025	110775	89536	110775	2		
H 5		SCREW,MACH,PH,P,STL,4-40X1.500	156380	73734	19032	2		
H 6		SCREW,MACH,SEMS,PH,P,STL,4-40X.500	353060	89536	353060	2		
H 7		WASHER,LOCK,SPLIT,STEEL,#4	110395	89536	110395	.		
J 1		SOCKET,1 ROW,PWB,0.100CTR,4 POS	461756	00779	583773-1	1		
J 2		CONN,PWB EDGE,REC,90,0.156CTR,12 POS	474007	05574	2VH6/1AKC15	1		
J 3		SOCKET,1 ROW,PWB,0.100CTR,6 POS	448209	00779	1-583773-3	1		
J 4		SOCKET,1 ROW,PWB,0.100CTR,7 POS	484030	00779	1-583773-4	1		
J 5		CONN D-SUB,PWB,RT ANGL,25 SCKT,.590	461996	00779	206584-1	1		
J 6		SOCKET,1ROW,PWB,0.100CTR,18POS	435024	00779	583773-8	1		
K 1		RELAY,REED,1 FORM A,4.5VDC	357582	71707	UF40070	1		
MP 1		NUT,PRESS,BROACH,STL,4-40	380196	24347	KF2-440	9		
MP 2		CABLE TIE,5-1/2"L,0.100"W,1.25 DIA	530360	89536	530360	1		
MP 3		HEAT,DIS,CLIP,TO-220	428805	13103	6046P8	1		
MP 4		BUTTON,MODIFIED,GREEN	644435	89536	644435	1		
MP 5		BUTTON,MODIFIED,LT. GRAY	540724	89536	540724	1		
Q 1, 2, 9,	*	TRANSISTOR,SI,N-JFET,TO-92	343830	12040	NSSF50024	9	1	
Q 12- 15, 17,	*		343830					
Q 22	*		343830					
Q 3, 25, 27	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	04713	2N3904	3	2	
Q 4, 6- 8,	*	TRANSISTOR,SI,N-JFET,TO-92	376475	15818	U2810J	8	1	
Q 10, 11, 16,	*		376475					
Q 21	*		376475					
Q 5	*	TRANSISTOR,SI,N-JFET,REMOTE CUTOFF	429977	89536	429977	1	1	
Q 18	*	TRANSISTOR,SI,N-JFET,DUAL,TO-71	419283	89536	419283	1	1	
Q 19, 20	*	DUAL FET,SELECTED OFFSET	476911	78425	476911	2	2	
Q 23, 24	*	TRANSISTOR,SI,BV= 80V, 10W,TO-202	495697	04713	MPS-U06	2	1	
Q 26	*	TRANSISTOR,SI,BV= 40V, 2W,TO-220	473207	01295	TIP30	1	1	
R 1		RES,WW,11.75K,+-0.05%,0.125W	603258	89536	603258	1		
R 2, 31, 47		RES,CF,10K,+-5%,0.25W	348839	80031	CR251-4-5P10K	3		
R 3		RES,CF,1K,+-5%,0.25W	343426	80031	CR251-4-5P1K	1		
R 6, 45		RES,MF,61.9K,+-1%,0.125W,100PPM	237230	91637	CMF556192F	2		
R 7, 44		RES,VAR,CERM,500,+-10%,0.5W	325613	89536	325613	2		
R 8, 32		RES,CF,3.3K,+-5%,0.25W	348813	80031	CR251-4-5P3K3	2		
R 9		RES,CF,43K,+-5%,0.25W	442418	80031	CR251-4-5P43K	1		
R 10		RES,CF,27K,+-5%,0.25W	441501	80031	CR251-4-5P27K	1		
R 11, 12, 22-		RES,MF,10.02K,+-0.1%,0.125W,50PPM	352245	89536	352245	6		
R 25			352245					
R 13		RES,MF,1K,+-1%,0.125W,100PPM	168229	91637	CMF551001F	1		
R 14		RES,VAR,CERMET,500K,+-10%,0.5W	474387	11236	360T-504A	1		
R 15		RES,MF,49.9,+-1%,0.125W,100PPM	305896	91637	CMF5549R9F	1		
R 16		RES,MF,169K,+-1%,0.125W,100PPM	289454	91637	CMF551693F	1		
R 17		RES,MF,215K,+-1%,0.125W,100PPM	289470	94637	CMF552153F	1	1	

An * in 'S' column indicates a static-sensitive part.

Table 5-2. A1 Main PCB Assembly (cont)

REFERENCE DESIGNATOR -A>-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	R S -Q	N O T -E-
R 18		RES,CF,12K,+-5%,0.25W	348847	80031	CR251-4-5P12K	1		
R 19		RES,MF,20K,+-1%,0.125W,100PPM	291872	91637	CMF552002F	1		
R 20		RES,MF,2K,+-1%,0.125W,100PPM	235226	91637	CMF552001F	1		
R 21		RES,MF,221,+-1%,0.125W,100PPM	340794	91637	CMF552210F	1		
R 26		RES,MF,100,+-0.1%,0.125W,25PPM	357400	91637	CMF551000B	1		
R 27		RES,VAR,CERM,1K,+-20%,0.5W	267856	11236	190PC102B	1		
R 28, 29		RES,VAR,CERM,10K,+-20%,0.5W	267880	75378	190PC103B	2		
R 30, 41		RES,CF,47K,+-5%,0.25W	348896	80031	CR251-4-5P47K	2		
R 33, 53		RES,CF,330,+-5%,0.25W	368720	80031	CR251-4-5P330E	2		
R 35		RES,CF,100,+-5%,0.25W	348771	80031	CR251-4-5P100E	1		
R 36		RES,MF,9.09K,+-1%,0.125W,100PPM	221663	91637	CMF559091F	1		
R 37		RES,MF,1.02K,+-1%,0.125W,100PPM	223545	91637	CMF551021F	1		
R 38		RES,MF,4.32K,+-1%,0.125W,100PPM	294819	91637	CMF554321F	1		
R 39		RES,MF,10K,+-1%,0.125W,100PPM	168260	91637	CMF551002F	1		
R 42		RES,CF,5.1K,+-5%,0.25W	368712	80031	CR251-4-5P5K1	1		
R 48		RES,CF,39K,+-5%,0.25W	442400	80031	CR251-4-5P39K	1		
R 49		RES,MF,100K,+-1%,0.125W,100PPM	248807	91637	CMF551003F	1		
R 50		RES,MF,64.9K,+-1%,0.125W,100PPM	288530	91637	CMF556493F	1		
R 51		RES,MF,226K,+-1%,0.125W,100PPM	320879	91637	CMF552263F	1		
R 52		RES,MF,309K,+-1%,0.125W,100PPM	235283	91637	CMF553093F	1		
R 55		RES,VAR,CERM,25K,+-10%,0.5W	500769	32997	3299W-W-253	1		
S 1		SWITCH PUSHBUTTON ASSY	483891	89536	483891	1		
S 3, 4		SWITCH,SLIDE,DPDT,POWER	234278	89536	234278	2	1	
T 1		POWER TRANSFORMER	464370	89536	464370	1		
T 2		TRANSF,INV,MULTIPLE OUTPUT,TOROID	461954	89536	461954	1		
TB 1		TERM STRIP,PWB,RT ANG,0.200CTR,2 POS	479006	89536	479006	1		
TP 1- 4, 6,		TERM,UNINSUL,FEEDTHRU,HOLE,TURRET	179283	88245	2010B-5	7		
TP 8, 16			179283					
U 1	*	IC,COMPARATOR,8 PIN DIP	352195	01295	SN72311P	1	1	
U 2	*	IC,OP AMP,JFET INPUT,TO-5 CASE	429837	12040	LF356F	1	1	
U 3, 7	*	IC,OP AMP,JFET INPUT,8 PIN DIP	472779	12040	LF386N	2	1	
U 4, 15	*	IC,OP AMP,GENERAL PURPOSE,8 PIN DIP	413740	12040	LM307N	2	1	
U 5	*	IC,OP AMP,SOURCE CNTRLD,DUAL,LO-NOISE	478032	04713	MC4558NCP1	1	1	
U 6A	*	RES NET ASSY TESTED (2180/2190 DIV)	510628	89536	519628	1		
U 6B	*	RES DIV RES NET ASSY TESTED 2180/2190	577536	89536	577536	1		
U 8		RES,NET,SIP,8 PIN,7 RES,47K,+-2%	413286	89536	413286	1		
U 10	*	IC,OP AMP,SELECTED GBW 600KHZ	418566	12040	LM358N	1	1	
U 11	*	IC,VOLT REG,FIXED,-15 VOLTS,1.5 AMPS	413179	04713	MC7915CP	1	1	
U 12	*	IC,VOLT REG,FIXED,+15 VOLTS,1.5 AMPS	413187	04713	MC7815CT	1	1	
U 13	*	IC,CMOS,HEX OPEN DRAIN BUFFER	473389	12040	MM74C906N	1	1	
U 14		RES,NET,DIP,16 PIN,8 RES,680,+-5%	402644	89536	402644	1	1	
U 16	*	IC,COMPARATOR,DUAL,LO-PWR,8 PIN DIP	478354	12040	LM393N	1	1	
VR 3, 4	*	ZENER,UNCOMP,36.0V,5%,3.4MA,0.4W	186163	04713	1N974B	2	1	
VR 18	*	ZENER,COMP, 6.4V, 2%, 2 PPM TC, 0.5MA	393579	04713	1N4567	1		
X 1		SOCKET,IC,40 PIN	329282	09922	DILB40P-108	1		
Y 1	*	CRYSTAL,4MHZ,+-0.02%,HC-18/U	474072	89536	474072	1		

An * in 'S' column indicates a static-sensitive part.

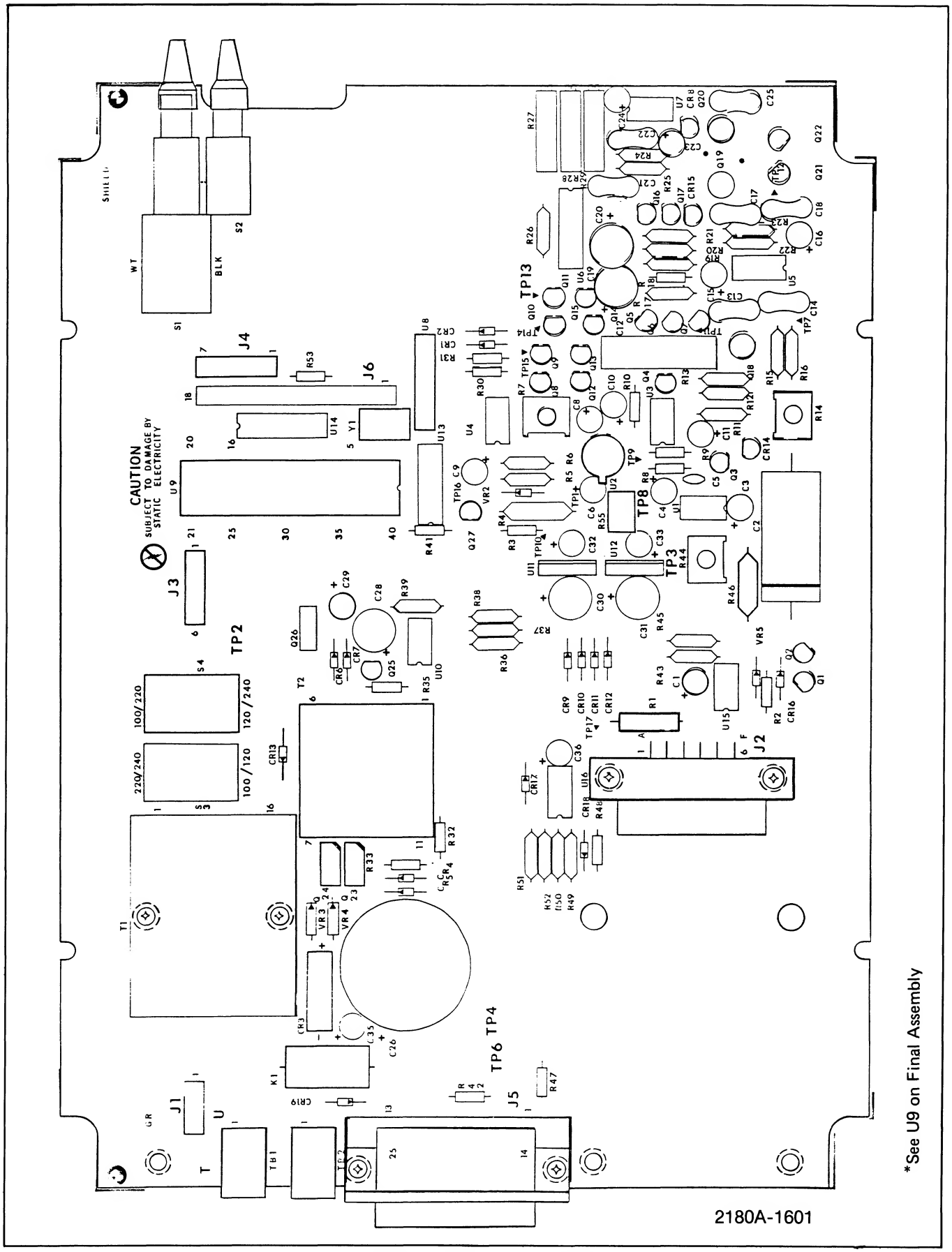


Figure 5-2. A1 Main PCB Assembly

Option -004
IEEE-488 Interface

604-1. INTRODUCTION

604-2. Option 21X0A-004 IEEE-488 Interface provides the 2180A and 2190A digital thermometers with a direct output only connection to the IEEE-488 bus.

604-3. Option 21X0A-004 may be ordered with the 2180A and 2190A thermometers for factory installation, or is available by itself for service center installation. Option 21X0A-004 cannot be used in a 2300A Scanner system. For more compatibility information, refer to "Compatibility With 2300A and Previously Produced Thermometers".

604-4. The IEEE-488 standard connector is accessible from the rear panel of the thermometer. The format of the output data includes the channel number, the current reading, and any out-of-range or open thermocouple information. (Refer to Table 604-3.)

604-5. SPECIFICATIONS

604-6. Specifications for Option 21X0A-004 are shown in Table 604-1.

NOTE

The L4 listener function indicates that the thermometer IEEE-488 bus interface has the same 5-digit talk and listen addresses, and that the receipt of a listen address disables the talk address.

604-7. IEEE-488 BUS ADDRESS CODE SELECTION

604-8. A six-position dip switch (SW3), located on Option 21X0A-004 pca (printed circuit assembly), sets the IEEE-488 bus address codes for the option. To gain access to SW3, lift off the case top of the thermometer by removing the six screws from the base. Referring to Table 604-2, set positions 1 through 5 of SW3 to assign the desired address.

604-9. OPERATION

604-10. Once Option 21X0A-004 is installed and SW3 is properly set, make sure that the IEEE-488 cable is correctly connected to the option to ensure that all functions are properly monitored by the controller.

604-11. Program Considerations

604-12. Position 6 on SW3 controls the SRQ signal (Service Request) to the IEEE-488 bus. Upon receiving an SRQ, the controller serially polls each device on the bus for SRQ status. SRQ status of the Option 21X0A-004 is indicated by bit DB6 (position 64 decimal, 40 hexadecimal) in the serial poll register (U12). With SW3 position 6 in the ON position, SRQ is generated when a LF (line feed) is received in the 32-byte buffer of Option 21X0A-004. The LF character is used by the thermometer to indicate the end of a data transfer to the Option 21X0A-004. (Refer to Table 604-3.) Option 21X0A-004 sets DB1 (2 decimal), which causes a serial poll to return a total value of decimal 66 or 42 hexadecimal.

604-13. When the SRQ mode is enabled, the SRQ is set when the thermometer makes a reading available to the Option 21X0A-004. The reading is held indefinitely until the SRQ is serviced. All new readings from the thermometer are discarded. When SRQ is disabled, the output buffer is continuously updated with the most recent reading from the thermometer. However, there may be a 0.33 second delay encountered in the returned reading. This delay occurs when one reading is sent across the IEEE bus and the Option 21X0A-004 waits for the thermometer to send the next reading. An IEEE bus timeout error may occur unless the timeout is set longer than this delay.

Table 604-1. Option 21X0A-004 Specifications

ENVIRONMENTAL	
Operating Power	100, 200, 220, 240V ac ± 10% 50/60 Hz, 3VA. (The 12-volt battery operation is not supported.)
Operating Temperature	40°C (Outside ambient of thermometer.)
OPERATIONAL CONTROL	Switch 3 (SW3)
OUT-OF-LIMIT-SIGNAL	Exclamation point transmitted with Option 21X0A-006 installed only; not with Y2002.
OUTPUT	
Protocol and Connections	IEEE-488 standard

IEEE-488 Interface Function Capability Codes

IDENTIFICATION	FUNCTION	CAPABILITY
SH1	Source Handshake	Full
AH1	Acceptor Handshake	Full
T6	Talker	Serial Poll (not talk only)
L4	Listener	Not listen only (see note)
SR1	Service Request	Full
DT1	Device Trigger	Full (see 604-22. for function description)

604-14. Message Format

604-15. Table 604-3. contains the sequence of information in the output data string. The sequence is the fixed length format presented on the IEEE bus.

604-16. Sample Programs

604-17. The following sample programs show two different situations in which the controller receives temperature readings from the thermometer. The program listed in Figure 604-1 instructs the controller to asynchronously retrieve a temperature reading after an SRQ has been sent from the thermometer. The program listed in Figure 604-2 instructs the controller to ask for a temperature reading at a specific program step.

604-18. SRQ Program

604-19. The SRQ program, when typed into a 1720A, 1722A, or 1752A controller informs the controller what to do when an SRQ is received from the thermometer. The program allows the controller to perform other tasks until the thermometer has a temperature reading. The thermometer sends a 66 hexadecimal value back to the controller in response to the serial poll (SPL). If more than one thermometer or more than one other instrument (a maximum of 14) is connected to the controller, the program distinguishes which instrument is sending the SRQ and determines priority if more than one SRQ is received at the same time. After the controller receives the temperature reading and prints it on the controller screen, the program ends the SRQ handling procedure and waits for another SRQ.

NOTE

The following programs are written in Fluke BASIC and operate on the 1720A, 1722A, and 1752A controllers. A modification of the SRQ program may be required to conform to other IEEE controllers.

604-20. The Non-SRQ Program

604-21. The sample program in Figure 604-2 inputs and prints temperature readings without the use of an SRQ. A 2-second delay is required after the TRIG @2 statement (line 50) to allow Option 21X0A-004 to finish the reset process before requesting readings from it. The TIMEOUT delay (line 70) must be set greater than 333 ms, so the controller waits for the thermometer to provide the next reading to the INPUT statement.

604-22. Group Execute Trigger

604-23. The Option 21X0A-004 responds to the IEEE-488 GET command by simply resetting the two microprocessors (U5 and U11) on the board. Resetting the microp-

Table 604-2. Switch 2, IEEE-488 Bus Address Selection

ADDRESS CODES	ADDRESS SWITCH SETTINGS				
	16 (5)	8 (4)	4 (3)	2 (2)	1 (1)
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0

```
10 ON ERROR GOTO 250                    !Initialization
20 ON CTRL/C GOTO 260                   !       "
30 INIT PORT 0                          !       "
40 CLEAR PORT 0                         !       "
50 TRIG @2                              !Send "Group Execute Trigger" to
60                                      !reset the -004, which is arbitrarily
70                                      !set at address 2 on Port 0.
80                                      !
90 ON SRQ GOTO 140                      !Now, tell the program what to do if an
100                                     !SRQ comes.
110                                     !
120 GOTO 120                            !Most of the time it just sits here.
130                                     !
140 IF SPL(2) <> 66 RESUME              !"spl(2)" clears the SRQ. The -004 sends
150                                     !a 66(42 Hex) if it set the SRQ,
160                                     !otherwise it sends a 0. This
170                                     !discriminates between other instruments
180                                     !on the Port that could send an SRQ.
190 INPUT @2,A$                         !This command gets the thermometer reading
200                                     !from the -004.
210 PRINT A$                            !This command prints the reading.
220 RESUME                              !Ends the SRQ handling and goes to wait
230                                     !for another.
240                                     !
250 PRINT 'OOPS!!!  ERROR #';ERR;' ON LINE #'; ERL
260 PRINT 'bye-bye'
270 END
```

Figure 604-1. SRQ Sample Program

Table 604-3. Message Format

CHARACTER POSITION

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

NORMAL TEMPERATURE MEASUREMENT DATA

CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	d	F/C	SP	!	SP	SP	CR	LF

OPEN THERMOCOUPLE OUTPUT (2190A only)

CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	d	F/C	SP	!	O	C	CR	LF

OVERLOAD OUTPUT

CH	CH	SP	SP	±	SP	D	D	D	D/.	D/.	D	SP	d	F/C	SP	!	O	L	CR	LF

SYMBOL	DESCRIPTION
CH	Channel identification numbers (00 through 99, 00 unless connected to Y2000, Y2001, or 2300A).
SP	Space
±	Plus or minus symbol
D	Temperature data values (0 through 9) for the 2180A, position 12 for the 2190A.
D/.	Either a temperature data value or a decimal point
d	a lower case (d)
F/C	Fahrenheit or Celsius
!	Character (!) when the present limit of the Limits Option 21X0A-006 is exceeded. One space if within limits.
OC	Open (thermo)couple (character positions 18 and 19)
OL	Overload (character positions 18 and 19)
CR	Carriage Return
LF	Line Feed

```
10 ON ERROR GOTO 250
20 ON CTRL/C GOTO 260
30 INIT PORT 0
40 CLEAR PORT 0
50 TRIG @2
60 WAIT 2000                          !Wait for -004 to finish reset process
70 TIMEOUT 350                        !Set IEEE timeout longer than reading delay
190 INPUT @2,A$                       !Request a reading
210 PRINT A$
220 GOTO 190
250 PRINT 'OOPS!!!  ERROR #';ERR;' ON LINE #';ERL
260 PRINT 'bye-bye'
270 END
```

Figure 604-2. Non-SRQ Sample Program

rocessors ensures that they are synchronized properly with the IEEE-488 interface chip (U12), and is a recommended start-up procedure at the beginning of the program in the IEEE-488 controller. A 2 second time delay is required to complete the resetting operation. Do not attempt to access Option 21X0A-004 before the end of the time delay.

604-24. Functional Equivalent

604-25. The operation of Option 21X0A-004 is functionally equivalent to the combination of the Fluke 21X0A-002, 2XXXA-522, and 1120A with the exception of the following four items:

CHANGES:

1. Option 21X0A-004 displays a lower case (d) instead of a blank in front of the temperature scale indicator. See Output Format, Table 604-3.

2. Option 21X0A-004 operates at the full speed rate of the thermometer, (3 readings per second, instead of 1.5 readings per second).

3. The 2XXXA-522 previously contained a buffer-full SRQ function that produced an SRQ when the 32-byte buffer is filled. The buffer-full SRQ function no longer exists with the 2XXXA-522, but the switch is still present and its function is still listed in the 2XXXA-522 manual. The buffer-full SRQ function is not available on Option 21X0A-004.

ADDED
FEATURE:

4. Option 21X0A-004 responds to a Group Execute Trigger. See Group Execute Trigger, paragraph 604-23.

604-26. If you include Option 21X0A-004 when upgrading or adding new equipment to a system currently operating with the 21X0A-002, 2XXXA-522, or 1120A combination, note the first two changes listed in paragraph 604-25.

604-27. THEORY OF OPERATION

604-28. Option 21X0A-004 converts the temperature displayed by the thermometer into a format usable by an IEEE-488 Bus Controller. Option 21X0A-004 communicates with the thermometer on the clocked bit-serial accessory bus. The channel number, range, conversion type, scale, and digits of the temperature reading are transmitted on the bus. The cycle is repeated every 333 ms. When the Write Address (WRTADR-) line is held low, Data Clock (DCLK-) clocks the accessory bus address then the thermometer data into the 3870 microprocessor (U5) on the DATA- line. In U5, the data is formatted (Table 604-2) and made available for transfer to the 8748 microprocessor (U11).

604-29. U5 applies a character to the tri-state buffers (U8 and U9) and pulls the Data Valid (DATVAL) line low. If U11 is not transferring data to U12 or if it is waiting for SRQ to be serviced, U11 responds to U5 by strobing the character onto the Option Data Bus with a STROBE- signal and reads the character into its 32-byte buffer. U11 also generates Acknowledge (ACK), which causes U5 to reply with a new character. When an LF character is detected, U11 unmasks the byte-out interrupt. If the SRQ switch is set to ON, the SRQ switch triggers the GPIA (General Purpose Interface Adapter) to send SRQ to the controller. The 32-byte buffer never completely fills because thermometer readings consist of 21 bytes.

604-30. The IEEE-488 Bus Controller initiates the talk mode by sending the talk address to the GPIA (U12) over the IEEE-488 bus when Attention (ATN) is asserted true low. The GPIA responds by setting the byte-out interrupt (U12-40) high, as a signal to U11 to pass data bytes to U12. The following three conditions must be met before data transfer can begin:

- Ready For Data (RFD) from the IEEE-488 bus is true (low).
- Data Accepted (DAC) from the IEEE-488 bus is false (high).
- U11 must have the byte-out interrupt unmasked.

604-31. When the above conditions are met, U11 sends the data byte to the Data Out Register of the GPIA via the Option Data Bus. At this time, the byte-out interrupt is set to zero, and the data byte is checked for the LF character. The GPIA handshakes the data byte to the IEEE-488 Bus, and the byte-out interrupt (U12-40), transmitted to U11, is set to 1. If the data byte is an LF character, EOI (End or Identify) is also sent to the IEEE Controller to signal the end of a data reading. This process continues as long as there is data in the 32-byte buffer of U11. When the 32-byte buffer is empty, U11 masks the byte-out interrupt from the GPIA.

604-32. The IEEE-488 address setting for Option 21X0A-004 is read by the GPIA (U12) via the Option 21X0A-004 data bus when the GPIA sends a strobe out on U12-4 to the address switch tri-state buffers (U18).

604-33. When the GPIA detects a Group Execute Trigger for its address, it sets U12-24 to a logic high to cause a

Power On Reset (POR) via Q4 and U16. The POR resets U5 and U11, and lasts for approximately 150 ms.

604-34. The power supply for Option 21X0A-004 power supply is a standard linear regulator using a full-wave center tap rectifier and pass transistor regulator (Q5). The regulator is driven by U17 and Q6, and is referenced from a 2.5-volt band gap reference (U15). U16 performs POR and low voltage detection. The option provides its own power rather than using the power supply of the thermometer, which is unable to provide enough additional power.

604-35. Option 21X0A-004 is a consolidation of the circuitry from Option 21X0A-002, Option 2XXXA-522, and 1120A that is required for IEEE-488 output operation. The consolidated circuitry does not include analog output capability or the slow serial communication link between the Option 21X0A-002 and 2XXXA-522 microprocessors. Instead, the circuitry uses the PTI (Portable Test Instrument) parallel output port of the Option 21X0A-002 to communicate with the Option 2XXXA-522 microprocessor.

604-36. COMPATIBILITY WITH 2300A AND PREVIOUSLY PRODUCED THERMOMETERS

604-37. Option 21X0A-004 is not intended to be used with a thermometer that is a part of a 2300A Scanning System. In a 2300A system, an Option 2300A-005 or Option 2300A-006 should be installed in the 2300A for connection to the IEEE-488 bus. Option 2300A-005 is for output only, similar to Option 21X0A-004 operation. Option 2300A-006 additionally provides remote control of the 2300A. Options 2300A-005 and 2300A-006 use the 2XXXA-522 and 1120A for connection to the IEEE bus.

CAUTION

Option 21X0A-004 is not compatible with a 2300A Scanning System. Such use may cause channel numbers to be displaced by one reading, and each reading may be output twice.

604-38. Option 21X0A-004 is not directly compatible with the earliest version of the 2180A and 2190A thermometers. A choice of either of the two modifications described below provides compatibility. To identify the early version of thermometer, observe the thermometer display as it is turned on. If the display characters begin with "2180" or "2190", the thermometer is an early version. Newer versions begin with "800" or "900."

604-39. If your thermometer is an early version, either of the following two modifications may be performed:

1. The microprocessor in the thermometer can be replaced with a newer version. Contact your local John Fluke Service Center to order the latest 2180A or 2190A standard versions.

   a. When you are updating a 2180A to the latest version, be aware there are changes in the available choice of Resistance Temperature Detector (RTD) linearizations. If you require the original linearizations, order a special retrofit kit Model 2180A/AYK. (P/N 796953)

   b. When you are selecting from the latest versions of 2190A linearizations, be aware that an enhanced microprocessor retrofit kit is also available. The enhanced retrofit kit provides 15 thermocouple types. Order Model 2190A/AMK (P/N 763292)

2. A modification to Option 21X0A-004 may alternatively be performed. Contact your local John Fluke Service Center and arrange for the installation of a 2180A-4021W (JF P/N 539288) onto Option 21X0A-004. Q1 and Q3 are removed from the pca and replaced by the modification circuit. This modification makes Option 21X0A-004 compatible with all versions of 2180A and 2190A thermometers. A +5 volt connection is provided next to U2 to provide power to the added modification circuit.

604-40. PERFORMANCE TEST

604-41. There are no adjustments or calibration.

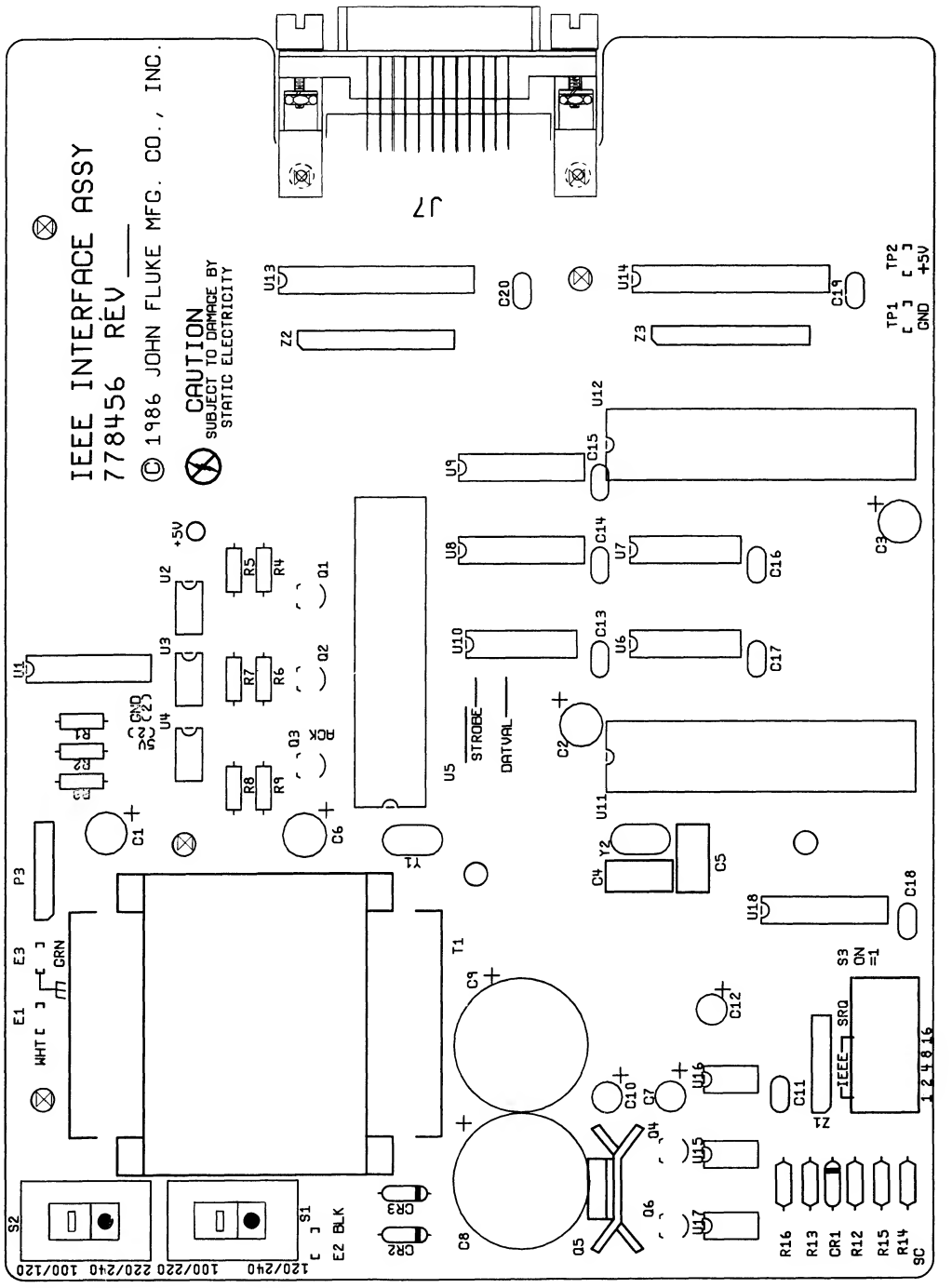
604-42. With Option 21X0A-004 attached to a 2180A or 2190A thermometer, apply proper ac input voltage and measure for 5.05 ± 0.1 volts dc across TP1 and TP2.

604-43. Connect Option 21X0A-004 to an IEEE-488 controller via the IEEE-488 bus. Execute the SRQ program in Figure 604-1 to retrieve readings from Option 21X0A-004.

Table 604-5. Option -004 IEEE-488 Interface PCB Assembly
(See Figure 604-3.)

REFERENCE DESIGNATOR -A>-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	R S -Q	N 0 T -E-
C 1, 2, 3,		CAP,TA,10UF,+-20%,20V	330662	56289	196D106X0020KA1	4		
C 6			330662					
C 4, 5		CAP,MICA,22PF,+-5%,500V	148551	02799	DM15C220J	2		
C 8, 9		CAP,AL,3300UF,+30-10%,16V,SOLV PROOF	603472	89536	603472	2		
C 10, 12, 16		CAP,TA,1UF,+-10%,35V	161919	56289	196D010X0035G	3		
C 11, 13- 20		CAP,CER,0.22UF,+-20%,50V,Z5U	519157	51406	RPE111Z5U224M50V	9		
CR 1	*	DIODE,SI,BV=75V,IO=150MA,500MW	203323	07910	1N4448	1		
CR 2, 3	*	DIODE,SI,100 PIV,1.5 AMP	116111	05277	1N4817	2	1	
E 1, 2, 3		TERM,FASTON,TAB,SOLDR,0.110 WIDE	512889	02660	62395	5	1	
H 1		SCREW,MACH,SEMS,PH,P,STL,6-32X0.375	177022	89536	177022	2		
H 2		NUT,HEX,S.STL,4-40	147611	89536	147611	2		
H 3		SCREW,MACH,PH,P,4-40X0.375	837690	89536	837690	2		
H 4		SCREW,CONNECTOR MOUNTING	429472	89536	429472	2		
H 5		NUT,MINI,HEX,SS,6-32	110569	89536	110569	2		
H 6		HARDWARE KIT (FOR J7)	435750	89536	435750	1		
H 7		WASHER,LOCK,SPLIT,STEEL,#4	110395	89536	110395	2		
J 7		CONN,MICRO-RIBBON,REC,PWB EDGE,24POS	484220	89536	484220	1		
MP 1		SPACER,POLY-E,SW-STANDOFF HT,0.063	285346	89536	285346	2		
MP 2		SHIELD, IEEE I/F ASSY.	795427	89536	795427	1		
P 3		CABLE,FLAT,JMPR,6 CONDUCT,0.100 SP	474155	00779	86942-5	1		
Q 1- 4, 6	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	04713	2N3904	5	1	
Q 1		RIVET,PUSH,BI,NYL,0.118X0.217	745869	89536	745869	1		
Q 2		HEAT DIS,VERT MT,1.25X0.875,TO-220	524934	13103	6025B-TT	1		
Q 5	*	TRANSISTOR,SI,BV= 40V, 2W,TO-220	473207	01295	TIP30	1	1	
R 1, 2, 3		RES,CF,10K,+-5%,0.25W	348839	80031	CR251-4-5P10K	3		
R 4, 6, 8		RES,CF,220K,+-5%,0.25W	348953	80031	CR251-4-5P220K	3		
R 5, 7, 9		RES,CF,2.2K,+-5%,0.25W	343400	80031	CR251-4-5P2K2	3		
R 12		RES,MF,226K,+-1%,0.125W,100PPM	320879	91637	CMF552263F	1		
R 13		RES,MF,309K,+-1%,0.125W,100PPM	235283	91637	CMF553093F	1		
R 14		RES,MF,10.2K,+-1%,0.125W,100PPM	293605	91637	CMF551022F	1		
R 15		RES,MF,10K,+-1%,0.125W,100PPM	168260	91637	CMF551002F	1		
R 16		RES,CF,100,+-5%,0.25W	348771	80031	CR251-4-5P100E	1		
S 1, 2		SWITCH,SLIDE,DPDT,POWER	234278	89536	234278	2		
S 3		SWITCH,DIP,DPST,PIANO,6 POS	800037	89536	800037	1		
T 1		5 VOLT TRANSFORMER	747881	89536	747881	1		
U 1	*	IC,CMOS,HEX BUFFER	381830	02735	CD4050AE	1	1	
U 2, 3, 4	*	ISOLATOR,OPTO,LED TO TRANSISTOR	380014	01295	T1L116	3	1	
U 5	*	IC,NMOS,8 BIT MICROCOMPUTR,2190A-9403	495309	89536	495309	1		
U 6	*	IC,LSTTL,QUAD 2 INPUT NAND GATE	393033	01295	SN74LS00N	1	1	
U 7	*	IC,LSTTL,HEX INVERTER	393058	01295	SN74LS04N	1	1	
U 8, 9, 18	*	IC,CMOS,HEX BUFFER W/3-STATE OUTPUT	407759	12040	MM80C97N	3	1	
U 10	*	IC,LSTTL,DUAL D F/F,+EDG TRG,W/CLR	393124	01295	SN74LS74N	1	1	
U 11	*	IC,NMOS,8 BIT MICROCOMPTR,1KX8 EPROM	454652	34649	C8748	1		
U 12	*	IC,NMOS,GEN PURPOSE INTERFACE ADAPTOR	477794	04713	MC68488P	1	1	
U 13, 14	*	IC,LSTTL,OCTL IEEE-488 BUS TRANSCVR	524835	04713	MC3447P	2	1	
U 15	*	IC, 2.5 V,40 PPM T.C.,BANDGAP REF	472845	04713	MC1403V	1	1	
U 16	*	IC,COMPARATOR,DUAL,LO-PWR,8 PIN DIP	478354	12040	LM393N	1	1	
U 17	*	IC,OP AMP,SELECTED DIFF OUT VOLT=2MV	473777	89536	473777	1	1	
XU 5, 11, 12		SOCKET,IC,40 PIN	429282	09922	DILB40P-108	3	1	
Y 1	*	CRYSTAL,4MHZ,+-0.02%,HC-18/U	474072	89536	474072	1	1	
Y 2	*	CRYSTAL,6MHZ,+-0.01%,HC-18/U	461665	89536	461665	1	1	
Z 1		RES,NET,SIP,6 PIN,5 RES,100K,+-2%	412726	89536	412726	1		
Z 2, 3		RES,NET,SIP,10 PIN,9 RES,100K,+-2%	461038	80031	95081002CL	2		

An * in 'S' column indicates a static-sensitive part.



CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

WARNING: ⊗ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1

21X0A-1601

Figure 604-3. Option -004 IEEE-488 Interface PCB Assembly

Option -006
Limits

606-1. INTRODUCTION

606-2. The 21X0-006 Limits Option gives the 2180A and 2190A Digital Thermometers the capability of providing both visual and electrical indications (alarms) when the temperature measurement exceeds either of a pair of selectable maximum/minimum limit values. Also selectable are, all for a single point, the delta function (displays the difference between the preset value and the temperature read), and the maximum/minimum display function (the highest or lowest temperature read since the last reset by the INITIALIZE MAX/MIN switch).

606-3. The Limits Option is available as factory installed with initial order or may be ordered as a field installable kit for addition to the instrument.

606-4. SPECIFICATIONS

606-5. Specifications for the Limits Option, 21X0-006, are as listed in Table 606-1.

Table 606-1. Specifications

Limits Function: lights LED and activates Form A (SPST) relay when a preset limit is exceeded. Contacts rated at 10 VA, 184V dc or 130V ac rms max, 0.5A max, resistive.
Min/Max Function: Store min or max readings, resettable from front panel.
△ **Temperature Function:** Reads ± temperature deviations from preset nominal temperature.
Installable: Factory or field, through pre-punched front panel.

Function:	**Limit:**
≤ Low Limit	−9999°
> High Limit	+9999°
Store min reading	Not used
Store max reading	Not used
△ ± Deviation from	Nominal

606-6. INSTALLATION

606-7. Options for field installation can be installed using the following procedure:

WARNING

HAZARDOUS VOLTAGES MAY BE PRESENT WITHIN THE INSTRUMENT. ONLY QUALIFIED PERSONNEL SHOULD PERFORM THIS INSTALLATION PROCEDURE.

1. Disconnect the thermometer from all power sources.

2. Remove the screws on the bottom of the case that fasten the top and bottom of the PTI case together and remove the top half of the case.

3. Remove the hole plugs from the Limits section of the front panel and attach the standoffs supplied with the option to the front panel.

4. Position the Limits PCB so that the thumbwheel LED and pushbutton switch line up with the applicable front panel ports.

5. Attach the Limits PCB to the Main PCB using the screws supplied with the option.

6. Connect the cable on the Limits PCB to J4 on the Main PCB.

7. Replace the PTI cover on the instrument and reconnect to input power sources, if required, at this time.

606-8. OPERATING NOTES

606-9. Installation of the Limits Option enables the low current single contact relay (K1) on the thermometer Main PCB. The contact points are available on a rear panel connector block.

NOTE

Once installed, there are no provisions for disabling the Limits Option. If a temperature display is desired without the relay or LED indications, select one of the Limits functions (> or ≤) and the maximum setting on the numeric thumbwheel switches.

606-10. OPERATION

606-11. The position and general description of the Limits Option front panel controls is given in Section 2. A more detailed description of the three functions is given in the following paragraphs. The term "thermocouple" = "RTD" for the 2180A.

606-12. Limits Function

606-13. The Limits function is enabled when the function portion of the thumbwheel is set in either the ≤ or > position. The front panel LED illuminates and the rear panel relay contacts close when either of the preset conditions are met. In the greater than (>) function the indications (LED and relay contacts) result from any temperature reading that exceeds the value set on the limits thumbwheels. The less than (≤) function gives its indication when the temperature read by the thermometer is equal to, or less than, the value set on the limits thumbwheels. The thumbwheel LSD is a whole number, fractional entries cannot be made.

606-14. Delta Function

606-15. When the Delta (Δ) function is selected on the thumbwheel the thermometer display reads the difference between the temperature at the thermocouple and the whole number setting of the thumbwheels. The formula used for the computation is:

T displayed = T at thermocouple - T thumbwheel setting (in degrees)

606-16. MINIMUM/MAXIMUM Display Function

606-17. The microcomputer acculmulates and stores the highest and lowest temperatures recorded since the last reset. When the Maximum (⤒) function is selected the highest temperature recorded and stored in the microcomputer is displayed. Selection of the Minimum function (⤓) displays the lowest recorded temperature since the last reset. To record the current temperature for either function, select the applicable function and depress the front panel reset switch.

606-18. THEORY OF OPERATION

606-19. The -006 Option supplies the thermometer with the function and numeric data selected on the front panel mechanical thumbwheel switches. When a Limits function is selected, the data is stored for comparison on the option pcb. All communication between the option and the thermometer is done on the clocked serial accessory bus. This bus transmits and receives addresses, thumbwheel data, reset data, and limit status. Refer to the schematic in Section 8 during the Theory of Operation discussion.

606-20. Addressing

606-21. Each of the options on the bus is addressed with a different code. The thermometer uses the address "6" to talk to the Limits Option. To talk to any option the $\overline{\text{WRTADR}}$ (P4-3) line must be brought low, with $\overline{\text{WRT}}$ (P4-4) high, followed by the applicable four address bits applied to the $\overline{\text{DATA}}$ (P4-5) line in succession, toggling $\overline{\text{DCLK}}$ (P4-6) for each bit. This clocks the address into the shift register (U2-15) where it is compared to the Limits Option address and, if valid, (U1-1 low) enables the gates required to shift data to the thermometer (U5-11) and into the Limits Option (U5-2). Details of the data transfer are in subsequent paragraphs.

606-22. Limits Option Outputs

606-23. Before the thermometer can input data from the Limits Option, the Limits circuitry must be addressed as described previously (U1-1 low). Once addressed the $\overline{\text{WRTADR}}$ and $\overline{\text{WRT}}$ lines go high. The low to high transition of $\overline{\text{WRTADR}}$ (U3-6) loads the shift registers from the thumbwheels and RESET switches. The two lines enable the output data line (U1-13) and as the thermometer accepts the data it clocks the serial output shift registers with $\overline{\text{DCLK}}$, transferring the data from the shift register to the thermometer.

606-24. In the thermometer the data is processed by the microcomputer to perform the proper action. For the Limits function the output is compared to the state of the limits and, if exceeded, the indicator illuminated and the relay energized. For the Delta function the temperature is compared against the transmitted value and the difference displayed. If either the Maximum or Minimum function is selected the stored value is displayed, but, in addition, the status of the RESET switch is checked.

606-25. Limits Option Inputs

606-26. The thermometer transmits to the Limits Option only the Limits Exceeded status. After the option has been addressed (U1-1) $\overline{\text{WRTADR}}$ goes high to

disable the addressing circuit (U4-13) while $\overline{WRT}$ stays low to enable the Limits Exceeded input (U5-8) so that $\overline{DCLK}$ can clock the data into the latch (U5-1). A Limits Exceeded indication clocks a high into the latch resulting in a low at the output (U6-12) to turn on CR1. The limit not exceeded or another function selected, loads a low into the latch to turn off the indicator.

606-27. CALIBRATION

606-28. The Limits Option has no variable components and does not require calibration.

606-29. TROUBLESHOOTING

606-30. Troubleshooting for the 2180A Option -006, Limits, consists of the tabular flow chart in Table 606-1. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

606-31. LIST OF REPLACEABLE PARTS

606-32. Table 606-2 is a list of replaceable parts for the Limits Option. Refer to Section 5 for an explanation of the columnar entries.

Table 606-2. Limits Option Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE *These tests are based on the assumption that the 2180A/2190A has been thoroughly checked out and is free of troubles prior to beginning the test of the Limits Option –006.*		
1	Select the less than or equal function (≤) and set the thumbwheels for a numeric such that the thermocouple input exceeds the preset numeric (e.g., thumbwheels set at +1111 and the ambient temperature used as the thermocouple input).		
2	Does the LIMIT indicator illuminate and the rear panel relay contacts close?	26	3
3	Is the +4 Vdc input from the Main PCB present?	5	4
4	Check the +5 Vdc input, repair as required then resume at Step 1.		
5	Does the signal at U1-1 toggle (vary between logic high and logic low) when viewed with a scope?	13	6
6	Do the $\overline{WRT}$, $\overline{WRTADR}$ and $\overline{DCLK}$ lines toggle?	8	7
7	Check the inputs on the cable from the microprocessor on the Main PCB. Repair as required then resume at Step 1.		
8	Does the $\overline{DATA}$ line toggle?	10	9
9	Check the cabling and Q1, Q2, U3-8 and their associated components. Repair as required then resume at Step 1.		
10	Are the clock and data signals present at pins 1 and 15 of U2, respectively?	12	11
11	Check U1, U2-2, 11, 12, 13 and U3. Repair as required then resume at Step 1.		
12	Check U4 for the clock and U6 for loading of the data line. Repair as required then resume at Step 1.		
13	Is the function code (≤) a BCD 0 with pins 4, 5, and 6 of U7 low, the sign (+) at U7-7 high, the numeric MSD BCD code as set at pins 1, 15, 14 and 13 of U9, the second MSD BCD code as set at pins 4, 5, 6, and 7 of U11?	15	14
14	Check the switches and their associated components. Reapir as required then resume at Step 1.		
15	Is the clock present at U7-10, U9-10, and U11-10?	17	16
16	Check U4-10, U1-13 and their inputs. Repair as required then resume at Step 1.		

Table 606-2. Limits Option Troubleshooting (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
17	Does the signal at U11-3, U9-3, and U7-3 toggle?	19	18
18	Check U11, U9, and U7. Repair as required then resume at Step 1.		
19	Does the $\overline{\text{DATA}}$ line toggle?	21	20
20	Check Q1, Q2, U3, U5-10 and their associated components. Repair as required then resume at Step 1.		
21	Are the clock and data signals present at pins 11 and 9 of U6, respectively?	23	22
22	Check U5 for the clock, repair as required then resume at Step 1.		
23	Is the collector of Q9 low?	25	24
24	Check Q9, Q3, U6-12 and their associated components. Repair as required then resume at Step 1.		
25	Check the indicator CR1 and the relay on the Main PCB. Repair as required then resume at Step 1.		
26	Set the FUNCTION switch to greater than (>) and input a temperature from the thermocouple that exceeds the preset limit.		
27	Does the LIMIT indicator illuminate and the relay contacts close?	29	28
28	Check for a Function BCD code of 1 (001) at pins 4, 5, and 6 of U7. The sign at U7-7 is high for plus and low for minus. Check that the thumbwheel switches reflect the BCD codes set on them. Repair as required then resume at Step 1.		
29	Set the FUNCTION switch to the Delta (△) position and set the thumbwheels to the desired base.		
30	Is the difference between the thermocouple input and the preset base displayed?	32	31
31	Check for a Function of BCD code of 2 (010) at pins 4, 5, and 6 of U7. Check that the thumbwheel switches reflect the BCD codes set on them. Repair as required then resume at Step 29.		
32	Set the FUNCTION switch to the minimum (⤓) position and depress the INITIALIZE MIN/MAX switch.	i n	
33	Does the thermometer display reflect the lowest temperature input from the thermocouple since the switch was depressed?	35	34
34	Check for a Function BCD code of 3 (011) at pins 4, 5, and 6 of U7. Check U2-4 and 5, U4-3 and 4, U6-1, the initialize switch S7 and their associated components. Repair as required then resume at Step 32.		
35	Set the FUNCTION switch to the MAXIMUM (⤒) position and depress the INITIALIZE MIN/MAX switch.		
36	Does the thermometer display reflect the highest temperature input from the thermocouple since the switch was depressed?	38	37
37	Check for a Function BCD code of 4 (100) at pins 4, 5, and 6 of U7. Repair as required then resume at Step 35.		
38	Troubleshooting of the 21X0-006 Limits Option is complete.		

Table 606-3. Option -006 Limits PCB Assembly
(See Figure 606-1.)

REFERENCE DESIGNATOR -A>-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	R S -Q	N O T -E-
CR 1	*	LED,RED,PCB MOUNT,LUM INT= >0.6 MCD	385914	09214	SSL-22	1		
H 1		SCREW,MACH,PH,PSTL,6-32X0.500	152173	89536	152173	2		
H 2		SCREW,MACH,SEMS,PH,P,STL,6-32X.500	177030	89536	177030	2		
MP 1		ACTUATOR, SWITCH	412106	89536	412106	1		
MP 2		COVER, PUSHBUTTON SWITCH	401299	89536	401299	1		
MP 3		BUTTON	472332	89536	472332	1		
MP 4		ASSY, LED STANDOFF	472548	89536	472548	1		
MP 5		SPACER,RND,S STEEL,0.143IDXO.250	484865	89536	484865	2		
P 4		CABLE,FLAT,JMPR,7 CONDUCT,0.100 SP	474379	00779	86946-6	1		
Q 1	*	TRANSISTOR,SI,PNP,SMALL SIGNAL	195974	64713	2N3906	1	1	
Q 2, 3, 9	*	TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	64713	2N3904	3		
R 1- 4, 6,		RES,CF,10K,+-5%,0.25W	348839	80031	CR251-4-5P10K	6		
R 8			348839					
R 5		RES,CF,100K,+-5%,0.25W	348920	80031	CR251-4-5P100K	1		
R 7		RES,CF,240,+-5%,0.25W	376624	80031	CR251-4-5P240E	1		
R 9		RES,CF,20K,+-5%,0.25W	441477	80031	CR251-4-5P20K	1		
R 10		RES,CF,2.2K,+-5%,0.25W	343400	80031	CR251-4-5P2K2	1		
S 1		SWITCH,ROTARY,MULT POS,SPECIAL,6THUMB	472803	89536	472803	1		
S 2		SWITCH PART,SPST,SPRING	414516	00779	63212	1		
S 3		SWITCH PART,SPST,FIXED CONTACT	416875	00779	62313	1	1	
U 1	*	IC,CMOS,DUAL 4 INPUT NAND GATE	355206	04713	NM14012CP	1	1	
U 2	*	IC,CMOS,DUAL,4BIT SER-IN,PAR-OUT SHFT	340125	04713	MC14015CP	1	1	
U 3	*	IC,CMOS,HEX INVERTER	404681	02735	CD4069BE	1	1	
U 4	*	IC,CMOS,QUAD 2 INPUT NOR GATE	355172	02735	CD4001AE	1	1	
U 5	*	IC,CMOS,TRIPLE 3 INPUT NOR GATE	355180	02735	CD4025AE	1	1	
U 6	*	IC,CMOS,DUAL D F/F,+EDG TRIG	340117	02735	CD4013AE	1	1	
U 7, 9, 11	*	IC,CMOS,DUAL D F/F,+EDG TRIG	380766	02735	CD4021AE	3	1	
U 8, 10, 12		RES,NET,SIP,8 PIN,7 RES,100K,+-2%	412908	89536	412908	3	1	

An * in 'S' column indicates a static-sensitive part.

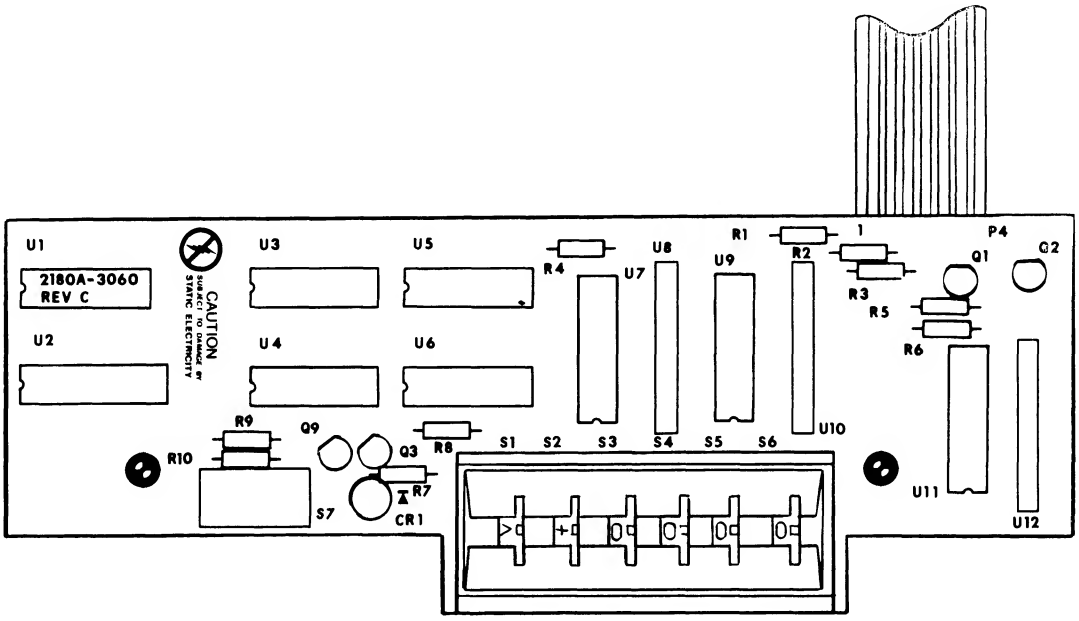


Figure 606-1. Option -006 Limits PCB Assembly

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

Federal Supply Codes for Manufacturers

D9816
Westermann Wilhelm Augusta-Anlage
Mannheim-Nackarau Germany

S0482
Sony Corp.
Tokyo, Japan

S3774
Oshino Electric Lamp Works
Tokoyo, Japan

0AD86
IN General
El Paso, TX

0AE89
Autosplice Inc.
Woodside, NY

0BW21
Noritake Co. Inc.
Burlington, MA

0ANF0
Topaz Semiconductor Inc
San Jose, CA

0DSM7
Conductive (Pkg) Containers Inc.
Brookfield, WI

0CLN7
Emhart Fastening Group
Shelton, CT

0FB81
S-Mos Systems Inc.
San Jose, CA

0FFP1
Eveready LTD
Ever Ready Special Battery Div.
Dawley Telford Salop UK

00199
Marcon Electronics Corp
Keamy, NJ

00213
Nytronics Comp. Group Inc.
Darrlingon, NC

00327
Welwyn International Inc.
Westlake, OH

00656
Aerovox Corp.
New Bedford, MA

00686
Film Capacitors Inc.
Passaic, NJ

00779
AMP, Inc.
Harrisburg, Pennsylvania

00853
Sangamo Weston Inc
Components Div
Pickens, NC

01091
Allied Plastics Co.
Los Angeles, CA

01101
Wabash Inc
(Formerly Wabash Magnetics)
Wabash, IN

01121
Allen Bradley Co.
Milwaukee, WI

01281
TRW Electronics & Defense Sector
R F Devices
Lawndale, CA

01295
TX Instruments Inc.
Semiconductor Group
Dallas, TX

01526
Genicom
Waynesboro, VA

01537
Motorola Communications &
Electronics Inc.
Franklin Park, IL

01686
RCL Electronics/Shallcross Inc.
Electro Components Div.
Manchester, NH

01884
Sprague Electric Co.
(Now 56289)

01961
Varian Associates Inc.
Pulse Engineering Div.
Convoy, CT

01963
Cherry Electrical Products Corp
Waukegan, IL

02111
Spectrol Electronics Corp.
City of Industry, CA

02114
Amperex Electronic Corp.
Ferrox Cube Div.
Saugerties, NY

02131
General Instrument Corp.
Government Systems Div.
Westwood, MA

02395
Sonar Radio Corp.
Hollywood, FL

02533
Leigh Instruments Ltd.
Frequency Control Div.
Don Mills, Ontario, Canada

02606
Fenwal Labs
Division of Travenal Labs
Morton Grove, IL

02660
Bunker Ramo-Eltra Corp.
Amphenol NA Div.
Broadview, IL

02697
Parker-Hannifin Corp.
O-Ring Div
Lexington, KY

02735
RCA-Solid State Div.
Somerville, NJ

02768
ITW (IL Tool Works)
Fastex Division
Des Plaines, IL

02799
Arco Electronics Inc.
Chatsworth, CA

03296
Nylon Molding Corp.
Monrovia, CA

03445
Lercon Electronics Inc
Burbank, CA

03508
General Electric Co.
Semiconductor Products
& Batteries
Auburn, NY

03797
Genisco Technology Corp.
Eltronics Div.
Rancho Dominquez, CA

03877
Gilbert Engineering Co.Inc
Incon Sub of Transitron
Electronic Corp.
Glendale, AZ

03888
KDI Electronics Inc.
Pyrofilm Div.
Whippany, NJ

03911
Clairex Corp.
Clairex Electronics Div.
Mount Vernon, NY

03980
Muirhead Inc.
Mountainside, NJ

04009
Cooper Industries, Inc.
Arrow Hart Div.
Hartford, CT

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, CA

04221
Midland-Ross Corp.
Midtex Div.
N. Mankato, MN

04222
AVX Corp.
AVX Ceramics Div.
Myrtle Beach, SC

04423
Telonic Berkley Inc.
Laguna Beach, CA

04713
Motorola Inc.
Semiconductor Group
Phoenix, AZ

04946
Standard Wire and Cable
Rancho Dominquez, CA

05173
General Radio
NY,NY.
Replaced by:

24655
Genrad,INC.
Concord, MA

05236
Jonathan Mfg. Co.
Fullerton, CA

05245
Corcom Inc.
Libertyville, IL

05276
ITT Pomona
Electronics Div.
Pomona, CA

05277
Westinghouse Elec. Corp.
Semiconductor Div.
Youngwood, PA

05347
Ultronix Inc
Grand Junction, CO

05397
Union Carbide Corp.
Materials Systems Div.
Cleveland. OH

05571
Sprague Electric Co.
(Now 56289)

05574
Viking Connectors Inc
Sub of Criton Corp.
Chatsworth, CA

05791
LYN-TRON
Burbank, CA

05820
EG & G Wakefield Engineering
Wakefield, MA

05839
Advance Electrical
Chicago, IL

05972
Loctite Corp.
Newington, CT

Federal Supply Codes for Manufacturers (cont)

06001
General Electric Co.
Electric Capacitor Product Section
Columbia, SC

06141
Fairchild Weston Systems Inc.
Data Systems Div.
Sarasota, FL

06192
La Deau Mfg. Co.
Glendale, CA

06229
Electrovert Inc.
Elmsford, NY

06383
Panduit Corp.
Tinley Park, IL

06473
Bunker Ramo Corp.
Amphenol NA Div.
SAMS Operation
Chatsworth, CA

06540
Mite Corp
Amatom-Electrical Div

06555
Beede Electrical Instrument
Penacook, NH

06665
Precision Monolithics
Sub of Boums Inc.
Santa Clara, CA

06666
General Devices Co. Inc.
INpolis, IN

06739
Electron Corp.
Littleton, CO

06743
Gould Inc.
Foil Div.
Eastlake, OH

06751
Components Inc.
Semcor Div.
Phoenix, AZ

06776
Robinson Nugent Inc.
New Albany, IN

06915
Richco Plastic Co.
Chicago, IL

06961
Vernitron Corp.
Piezo Electric Div.
Bedford, OH

06980
EIMAC
(See Varian)
San Carlos, CA

07047
Ross Milton Co., The
Southampton, PA

07138
Westinghouse Electric Corp.
Industrial & Govemment Tube Div.
Horseheads, NY

07233
Benchmark Technology Inc.
City of Industry, CA

07239
Biddle Instruments
Blue Bell, PA

07256
Silicon Transistor Corp.
Sub of BBF Inc.
Chelmsford, MA

07261
Avnet Corp.
Culver City, CA

07263
Fairchild Semiconductor
North American Sales
Ridgeview, CT

07344
Bircher Co. Inc., The
Rochester, NY

07374
Optron Corp
Woodbridge, CT

07557
Campion Co. Inc.
Philadelphia, PA

07597
Bumdy Corp.
Tape/Cable Div.
Rochester, NY

07716
TRW Inc. (Can use 11502)
IRC Fixed Resistors/ Burlington
Burlington, VT

07792
Lerma Engineering Corp.
Northampton, MA

07810
Bock Corp.
Madison, WI

07910
Teledyne Semiconductor
Mtn. View, CA

07933
Raytheon Co.
Semiconductor Div.
Mountain View, CA

08FG6
Calmos Systems Inc.
Kanata, Ont. Canada

080A9
Dallas Semiconductor
Dallas, TX

08111
MF Electronics
New Rochelle, NY

08235
Industro Transistor Corp.
Long Island City, NY

08261
Spectra-Strip
An Eltra Co.
Garden Grove, CA

08445
Electri-Cord Mfg., Inc
Westfield, PA

08530
Reliance Mica Corp.
Brooklyn, NY

08718
ITT Cannon Electric
Phoenix Div.
Phoenix, AZ

08806
General Electric Co.
Minature Lamp Products
Cleveland, OH

08863
Nylomatic
Fallsington, PA

08988
Skottie Electronics Inc.
Archbald, PA

09021
Airco Inc.
Airco Electronics
Bradford, PA

09023
Cornell-Dublier Electronics
Fuquay-Varina, NC

09214
General Electric Co.
Semiconductor Products Dept.
Aubum, NY

09353
C and K Components Inc.
Newton, MA

09423
Scientific Components Inc.
Santa Barbara, CA

09922
Bumdy Corp.
Norwalk, CT

09969
Dale Electronics Inc.
Yankton, SD

09975
Burroughs Corp.
Electronics Components
Detroit, MI

1A791
LFE Electronics
Danvers, MA

1B715
(United Shoe & Nylock Corp)
-Nylock Fastener Corp.-
Paramus, NJ

10059
Barker Engineering Corp.
Kenilworth, NJ

10389
IL Tool Works Inc.
Licon Div.
Chicago, IL

11236
CTS Corp.
Resistor Products Div.
Berne, IN

11237
CTS Corp of CA
Electro Mechanical Div.
Paso Robles, CA

11295
ECM Motor Co.
Schaumburg, IL

11358
Columbia Broadcasting System
CBS Electronic Div.
Newburyport, MA

11403
Vacuum Can Co.
Best Coffee Maker Div.
Chicago, IL

11502 (can also use 35009)
TRW Inc.
TRW Resistive Products Div.
Boone, NC

11503
Keystone Columbia Inc.
Freemont, IN

11532
Teledyne Relays Teledyne Industries Inc.
Hawthorne, CA

11711
General Instrument Corp.
Rectifier Div.
Hicksville, NY

11726
Qualidyne Corp.
Santa Clara, CA

12014
Chicago Rivet & Machine Co.
Naperville, IL

12020
Ovenaire
Div. of Electronic Technologies
Charlottesville, VA

12038
Simco
(Div of Ransburg Corp)
Hatfield, PA

12040
National Semiconductor Corp.
Danbury, CT

12060
Diodes Inc.
Northridge, CA

12136
PHC Industries Inc.
Formerly Philadelphia Handle Co.
Camden, NJ

12300
AMF Canada Ltd.
Potter-Brumfield
Guelph, Ontario, Canada

12323
Practical Automation Inc.
Shelton, CT

12327
Freeway Corp.
Cleveland, OH

12406
Elpac Electronics Inc.
Santa Ana, CA

12443
Budd Co.,The
Plastics Products Div.
Phoenixville, PA

12581
Hitachi Metals Inernational Ltd.
Hitachi Magna-Lock Div.
Big Rapids, MO

12615
US Terminals Inc.
Cincinnati, OH

12617
Hamlin Inc.
LaKe Mills, WI

12673
Wesco Electrical
Greenfield, MA

12697
Clarostat Mfg. Co. Inc.
Dover, NH

12749
James Electronic Inc.
Chicago, IL

12856
MicroMetals Inc.
Anaheim, CA

12881
Metex Corp.
Edison, NJ

12895
Cleveland Electric Motor Co.
Cleveland, OH

12954
Microsemi Corp.
Components Group
Scottsdale, AZ

12969
Unitrode Corp.
Lexington, MA

13050
Potter Co.
Wesson, MS

13103
Thermalloy Co., Inc.
Dallas, TX

13327
Solitron Devices Inc.
Tappan, NY

13511
Bunker-Ramo Corp.
Amphenol Cadre Div.
Los Gatos, CA

13606
Sprague Electric Co.
(Use 56289)

13689
SPS Technologies Inc.
Hatfield, NJ

13764
Micro Plastics
Flippin, AZ

13919
Burr-Brown Research Corp.
Tucson, AZ

14099
Semtech Corp.
Newbury Park, CA

14140
McGray-Edison Co.
Commercial Development Div.
Manchester, NH

14189
Ortronics, Inc.
Orlando, FL

14193
Cal-R-Inc.
Santa Monica, CA

14301
Anderson Electronics
Hollidaysburg, PA

14329
Wells Electronics Inc.
South Bend, IN

14482
Watkins-Johnson Co.
Palo Alto, CA

14552
Microsemi Corp.
(Formerly Micro-Semiconductor)
Santa Ana, CA

14604
Elmwood Sensors, Inc
Pawtucket, RI

14655
Comell-Dublier Electronics
Div. of Federal Pacific
Electric Co. Govt Cont Dept.
Newark, NJ

14704
Crydom Controls
(Division of Int Rectifier)
El Segundo, CA

14752
Electro Cube Inc.
San Gabriel, CA

14936
General Instrument Corp.
Discrete Semi Conductor Div.
Hicksville, NY

14949
Trompeter Electronics
Chatsworth, CA

15412
Amtron
Midlothian, IL

15542
Scientific Components Corp.
Mini-Circuits Laboratory Div.
Brooklyn, NY

15636
Elec-Trol Inc.
Saugus, CA

15782
Bausch & Lomb Inc.
Graphics & Control Div.
Austin, TX

15801
Fenwal Eletronics Inc.
Div. of Kidde Inc.
Framingham, MA

15818
Teledyne Inc. Co.
Teledyne Semiconductor Div.
Mountain View, CA

15849
Useco Inc.
(Now 88245)

15898
International Business
Machines Corp.
Essex Junction, VT

16068
International Diode Div.
Harrison, NJ

16162
MMI
Southfield, MI

16245
Conap Inc.
Olean, NY

16258
Space-Lok Inc.
Burbank, CA

16352
Codi Corp.
Linden, NJ

16469
MCL Inc.
LaGrange, IL

16473
Cambridge Scientific Industries
Div. of Chemed Corp.
Cambridge, MD

16733
Cablewave Systems Inc.
North Haven, CT

16742
Paramount Plastics
Fabricators Inc.
Downey, CA

16758
General Motors Corp.
Delco Electronics Div.
Kokomo, IN

17069
Circuit Structures Lab
Burbank, CA

17117
Electronic Molding Corp.
Woonsocket, RI

17338
High Pressure Eng. Co. Inc.
OK City, OK

17504
Aluminum Filter Co.
Carpinteria, CA

17545
Atlantic Semiconductors Inc.
Asbury Park, NJ

17745
Angstrohm Precision, Inc.
Hagerstown, MD

17856
Siliconix Inc.
Santa Clara, CA

18178
E G & Gvactee Inc.
St. Louis, MO

18235
KRL/Bantry Components Inc.
Manchester, NH

18310
Concord Electronics
New York, NY

18324
Signetics Corp.
Sacramento, CA

18377
Parlex Corp.
Methuen, MA

18520
Sharp Electronics Corp.
Paramus, NJ

18542
Wabash Inc.
Wabash Relay & Electronics Div.
Wabash, IN

Federal Supply Codes for Manufacturers (cont)

18565
Chomerics Inc.
Woburn, MA

18612
Vishay Intertechnology Inc.
Vishay Resistor Products Group
Malvern, PA

18632
Norton-Chemplast
Santa Monica, CA

18677
Scanbe Mfg. Co.
Div. of Zero Corp.
El Monte, CA

18736
Voltronics Corp.
East Hanover, NJ

18786
Micro-Power
Long Island City, NY

18927
GTE Products Corp.
Precision Material Products
Business Parts Div.
Titusville,PA

19080
Robinson Electronics Inc.
San Luis Obispo, CA

19112
Garry Corp.
Langhorne, PA

19315
Bendix Corp., The
Navigation & Control Group
Terboro, NJ

19451
Perine Machine Tool Corp.
Kent, WA

19482
Delta Electronics
Alexandria, VA

19613
MN Mining & Mfg. Co.
Textool Products Dept.
Electronic Product Div.
Irving, TX

19647
Caddock Electronics Inc.
Riverside, CA

19701
Mepco/Centralab Inc.
A N. American Philips Co.
Mineral Wells, TX

2B178
Wire Products
Cleveland, OH

2K262
Boyd Corporation
Portland, OR

2Y384
North American Philips Lighting Corp.
Van Wert, OH

20584
Enochs Mfg. Inc.
INpolis, IN

20891
Cosar Corp.
Dallas, TX

21317
Electronics Applications Co.
El Monte, CA

21604
Buckeye Stamping Co.
Columbus, OH

21845
Solitron Devices Inc.
Semiconductor Group
Rivera Beach, FL

21847
Aertech
Now TRW Microwave Inc.
Sunnyvale, CA

21962
Vectron Corp.
Replaced by: S.W. Electronics

22526
DuPont, EI DeNemours & Co. Inc.
DuPont Connector Systems
Advanced Products Div.
New Cumberland, PA

22626
Micro Semiconductor
(Now 14552)

22670
GM Nameplate
Seattle, WA

22767
ITT Semiconductors
Palo Alto, CA

22784
Palmer Inc.
Cleveland, OH

23050
Product Comp. Corp.
Mount Vernon, NY

23223
CTS Microelectronics
Lafayette, NY

23237
I.R.C., Inc.
Microcircuits Divison
Philadelphia, PA

23302
S.W. Electronics & Mfg. Corp.
Cherry Hill, NJ

23730
Mark Eyelet and Stamping Inc.
Wolcott, CT

23732
Tracor Applied Sciences Inc.
Rockville, MD

23880
Stanford Applied Engineering
Santa Clara, CA

23936
William J. Purdy Co.
Pamotor Div.
Burlingame, CA

24347
Penn Engineering Co.
S. El Monte, CA

24355
Analog Devices Inc.
Norwood, MA

24444
General Semiconductor
Industries, Inc.
Tempe, AZ

24546
Bradford Electronics
Bradford, PA

24618
Transcon Mfg.
Now: D.J. Associates Inc.

24655
Genrad Inc.
(Replaced General Radio 05173)
Concord, MA

24759
Lenox-Fugle Electronics Inc.
South Plainfield, NJ

24796
AMF Inc.
Potter & Brumfield Div.
San Juan Capistrano, CA

24931
Specialty Connector Co.
Greenwood, IN

24995
ECS
Grants Pass, OR

25088
Siemen Corp.
Isilen, NJ

25099
Cascade Gasket
Kent, WA

25403
Amperex Electronic Corp.
Semiconductor & Micro-Circuit Div.
Slatersville, RI

25435
Moldtronics, Inc
Downers Grove, IL

25706
Daburn Electronic & Cable Corp.
Norwood, NJ

26402
Lumex,Inc.
Bayshore, NY

26629
Frequency Sources Inc.
Sources Div.
Chelmsford, MA

26806
American Zettler Inc.
Irvine, CA

27014
National Semiconductor Corp.
Santa Clara, CA

27167
Corning Glass Works Corning
Electronics
Wilmington, NC

27264
Molex Inc.
Lisle, IL

27440
Industrial Screw Products
Los Angeles, CA

27494
Staffall, Inc.
Providence, RI

27745
Associated Spring Barnes Group Inc.
Syracuse, NY

27918
Component Parts Corp.
Bellmore, NY

27956
Relcom (Now 14482)

28175
Alpha Metals
Chicago, IL

28198
Positronic Industries
Springfield, MO

28213
MN Mining & Mfg. Co.
Consumer Products Div.
3M Center
Saint Paul, MN

28309
Kaiser
Minette,AL.

28425
Serv-O-Link
Euless, TX

28478
Deltrol Corporation
Deltrol Controls Div.
Milwaukee, WI

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, CA

Federal Supply Codes for Manufacturers (cont)

28484
Emerson Electric Co.
Gearmaster Div.
McHenry, IL

28520
Heyco Molded Products
Kenilworth, NJ

28932
Lumax Industrials, Inc
Altoona, PA

29083
Monsanto Co.
Santa Clara, CA

29604
Stackpole Components Co.
Raleith, NC

29907
Omega Engineering Inc.
Stamford, CT

3D536
Aimsco Inc.
Seattle, WA

30035
Jolo Industries Inc.
Garden Grove, CA

30045
Solid Power Corp.
Farmingdale, NY

30146
Symbex Corp.
Painesville, OH

30148
AB Enterprise Inc.
Ahoskie, NC

30161
Aavid Engineering Inc.
Laconia, NH

30315
Itron Corp.
San Diego, CA

30323
IL Tool Works Inc.
Chicago, IL

30800
General Instrument Corp.
Capacitor Div.
Hicksville, NY

30838
Fastec
Chicago,ILL

31019
Solid State Scientific Inc.
Willow Grove, PA

31091
Alpha Industries Inc.
Microelectronics Div.
Hatfield, PA

31323
Metro Supply Company
Sacramento, CA

31433
Kemet Electonics Corp.
Simpsonville, NC

31448
Army Safeguard Logistics Command
Huntsville, AL

31471
Gould Inc
Semiconductor Div
Santa Clara, CA

31522
Metal Masters Inc.
Baldwin, MS

31746
Cannon Electric
Woodbury, TN

31827
Budwig
Ramona, CA

31918
ITT-Schadow
Eden Prairie, MN

32293
Intersil
Cupertino, CA

32539
Mura Corp.
Westbury, Long Island, N.Y.

32559
Bivar
Santa Ana, CA

32719
Siltronics
Santa Ana, CA

32767
Griffith Plastics Corp.
Burlingame, CA

32879
Advanced Mechanical Components
Northridge, CA

32897
Murata Erie North America Inc.
Carlisle Operations
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Div.
Riverside, CA

33025
M/A ComOmni Spectra, Inc. (Replacing Omni Spectra)
Microwave Subsystems Div.
Tempe, AZ

33096
CO Crystal Corp.
Loveland, CO

33173
General Electric Co.
Owensboro, KY

33246
Epoxy Technology Inc.
Billerica, MA

33292
Pioneer Sterilized Wiping Cloth Co.
Portland, OR

33297
NEC Electronics USA Inc.
Electronic Arrays Inc. Div.
Mountain View, CA

33919
Nortek Inc.
Cranston, RI

34114
Oak Industries
Rancho Bernardo, CA

34263
CTS Electronics Corp.
Brownsville,TX

34333
Silicon General Inc.
Garden Grove, CA

34335
Advanced Micro Devices (AMD)
Sunnyvale, CA

34359
MN Mining & Mfg. Co.
Commercial Office Supply Div.
Saint Paul, MN

34371
Harris Corp.
Harris Semiconductor
Products Group
Melbourne, FL

34576
Rockwell International Corp.
Newport Beach, CA

34641
Instrument Specialties
Euless, TX

34649
Intel Corp.
Santa Clara, CA

34802
Electromotive Inc.
Kenilworth, NJ

34848
Hartwell Special Products
Placentia, CA

35009
Renfrew Electric Co. Ltd.
IRC Div.
Toronto, Ontario, Canada

35986
Amrad
Melrose Park, IL

36665
Mitel Corp.
Kanata, Ontario, Canada

36701
Van Waters & Rogers
Valley Field, Quebec, Canada

37942
Mallory Capacitor Corp.
Sub of Emhart Industries
INpolis, IN

39003
Maxim Industries
Middleboro, MA

4F434
Plastic Sales
Los Angeles, CA

40402
Roderstein Electronics Inc.
Statesville, NC

42498
National Radio
Melrose, MA

43543
Nytronics Inc.(Now 53342)

43744
Panasonic Industrial Co.
San Antonio, TX

43791
Datron Systems
Wilkes Barre, PA

44655
Ohmite Mfg. Co.
Skokie, IL

47001
Lumberg Inc.
Richmond, VA

47379
ISOCOM
Campbell, CA

49569
IDT (International Development & Trade)
Dallas, TX

49671
RCA Corp.
New York, NY

49956
Raytheon Company
Executive Offices
Lexington, MA

5D590
Mostek Corp.
Replaced by: SGS Thompson Microelectronics

5F520
Panel Components Corp.
Santa Rosa, CA

5P575
Nobel Electronics
Suffem, NY

5W664
NDK
Div. of Nihon Dempa Kogyo LTD
Lynchburg, VA

Federal Supply Codes for Manufacturers (cont)

5U802
Dennison Mfg. Co.
Framingham, MA

50088
SGS - Thomson Microelectronics Inc.
Carrollton, TX

50120
Eagle-Picher Industries Inc.
Electronics Div.
CO Springs, CO

50157
Midwest Components Inc.
Muskegon, MS

50356
Teac Corp. of America
Industrial Products Div
Montebello, CA

50364
MMI, Inc.(Monolithic Memories Inc)
Military Products Div.
Santa Clara, CA

50472
Metal Masters, Inc.
City of Industry, CA

50541
Hypertronics Corp.
Hudson, MA

50558
Electronic Concepts, Inc.
Eatontown, NJ

50579
Litronix Inc.
Cupertino, CA

50891
Semiconductor Technology
Stuart, FL

50934
Tran-Tec Corp
Columbus, NE

51167
Aries Electronics Inc.
Frenchtown, NJ

51284
Mos Technology
Norristown, PA

51249
Heyman Mfg. Co.
Cleveland, OH

51372
Verbatim Corp.
Sunnyvale, CA

51398
MUPAC Corp.
Brockton, MA

51406
Murata Erie, No. America Inc.
(Also see 72982)
Marietta, GA

51499
Amtron Corp.
Boston, MA

51506
Accurate Screw Machine Co.
(ASMCO) Nutley, NJ

51605
CODI Semiconductor Inc.
Kenilworth, NJ

51642
Centre Engineering Inc.
State College, PA

51705
ICO/Rally
Palo alto, CA

51791
Statek Corp.
Orange, CA

51984
NEC America Inc.
Falls Church, VA

52063
Exar Integrated Systems
Sunnyvale, CA

52072
Circuit Assembly Corp.
Irvine, CA

52152
MN Mining & Mfg.
Saint Paul, MN

52333
API Electronics
Haugpauge,Long Island,NY

52361
Communication Systems
Piscataway, NJ

52500
Amphenol, RF Operations
Burlington, MA

52525
Space-Lok Inc.
Lerco Div.
Burbank, CA

52531
Hitachi Magnetics
Edmore, MO

52745
Timco
Los Angeles, CA

52763
Stettner-Electronics Inc.
Chattanooga, TN

52769
Sprague-Goodman Electronics Inc.
Garden City Park, NY

52771
Moniterm Corp.
Amatrom Div.
Santa Clara, CA

52840
Western Digital Corp.
Costa Mesa, CA

53021
Sangamo Weston Inc.
(See 06141)

53036
Textool Co.
Houston, TX

53184
Xciton Corp.
Lathan, NY

53217
Technical Wire Products Inc.
Santa Barbara, CA

53342
Opt Industries Inc.
Phillipsburg, NJ

53673
Thompson CSF Components Corp.
(Semiconductor Div)
Conaga Park, CA

53718
Airmold/W. R. Grese & Co.
Roanoke Rapids, NC

53848
Standard Microsystems
Hauppauge, NY

53894
AHAM Inc.
RanchoCA, CA

53944
Glow-Lite
Pauls Valley, OK

54178
Plasmetex Industries Inc.
San Marcos, CA

54294
Shallcross Inc.
Smithfield, NC

54453
Sullins Electronic Corp.
San Marcos, CA

54473
Matsushita Electric Corp.
(Panasonic)
Secaucus, NJ

54492
Cinch Clamp Co., Inc.
Santa Rosa, CA

54583
TDK
Garden City, NY

54590
RCA Corp
Distribution & Special Products
Cherry Hill, NY

54869
Piher International Corp.
Arlington Heights, IL

54937
DeYoung Mfg.
Bellevue, WA

54590
RCA Corp.
Electronic Components Div.
Cherry Hill, NJ

55026
American Gage & Machine Co.
Simpson Electric Co. Div.
Elgin, IL

55112
Plessey Capacitors Inc.
(Now 60935)

55261
LSI Computer Systems Inc.
Melville, NY

55285
Bercquist Co.
Minneapolis, MN

55322
Samtech Inc.
New Albany, IN

55408
STI-CO Industries Co
Buffalo, NY

55464
Central Semiconductor Corp.
Hauppauge, NY

55557
Microwave Diode Corp.
W.Stewarstown, NH

55566
R A F Electronic Hardware Inc.
Seymour, CT

55576
Synertek
Santa Clara, CA

55680
Nichicon/America/Corp.
Schaumburg, IL

55943
D J Associates, Inc
(Replaced Transcon Mfg.-24618)
Fort Smith, AZ

56282
Utek Systems Inc.
Olathe, KS

56289
Sprague Electric Co.
North Adams, MA

56365
Square D Co.
Corporate Offices
Palatine, IL

56375
WESCORP
Div. Dal Industries Inc
Mountain View, CA

56481
Shugart Associates
Sub of Xerox Corp.
Sunnyvale, CA

56637
RCD Components Inc.
Manchester, NH

56708
Zilog Inc.
Campbell, CA

56856
Vamistor Corp. of TN
Sevierville, TN

56880
Magnetics Inc.
Baltimore, MD

57026
Endicott Coil Co. Inc.
Binghamton, NY

57053
Gates Energy Products
Denver, CO

57170
Cambridge Thermionic
Cambridge, MA
Replaced by:
71279
Interconnection Products Inc.

57668
R-ohm Corp
Irvine, CA

57962
SGS - Thomson Microelectronics Inc
Montgomeryville, PA

58014
Hitachi Magnalock Corp.
(Now 12581)

58104
Simco
Atlanta, GA

58364
BYCAP Inc.
Chicago, IL

58451
Precision Lamp
Cotat, CA

58474
Superior Electric Co.
Bristol, CT

58614
Communications Instruments Inc.
Fairview, NC

59124
KOA-Speer Electronics Inc.
Bradford, PA

59422
Holmberg Electronics
Irvine, CA

59610
Souriau Inc
Valencia, CA

59635
HV Component Associates
Howell, NJ

59640
Supertex Inc.
Sunnyvale, CA

59660
Tusonix Inc.
Tucson, AZ

59730
Thomas and Betts Corp.
IA City, IA

59831
Semtronics Corp.
Watchung, NJ

6H053:
American Components Inc.
an Insilco Co. RPC Div.
Hayesville, NC

6L611
Allen, Robert G. Inc.
Van Nuys, CA

6U850
Burgess Switch Co., Inc
Northbrook, IL

6U095
AMD Enterprises, Inc.
Roswell, GA

6X403
SGS/ATES Semiconductor Corp.
INpolis, IN

6Y440
Micron Technology Inc.
Boise, ID

60046
Power Dynamics Inc
West Orange, NJ

60197
Precicontact Inc.
Langhome, PA

60386
Squires Electronics Inc
Cornelius, OR

60395
Xicor Inc.
Milpitas, CA

60399
Torin Engineered Blowers
Div. of Clevepak Corp.
Torrington, CT

60496
Micrel Inc.
Sunnyvale, CA

60705
Cera-Mite Corp.
(formerly Sprague)
Grafton, WI

60911
Inmos Corp.
CO Springs, CO

60935
Westlake Capacitor Inc.
Tantalum Div.
Greencastle, IN

60958
ACIC
Intercomp Wire & Cable Div.
Hayesville, NC

61271
Fujitsu Microelectronics Inc
San Jose, CA

61394
SEEQ Technology Inc.
San Jose, CA

61429
Fox Electronics
Cape Coral, FL

61529
Aromat Corp.
New Providence, NJ

61752
IR-ONICS Inc
Warwick, RI

61772
Integrated Device Technology
Santa Clara, CA

61802
Toshiba
Houston, TX

61857
SAN-O Industrial Corp.
Bohemia, Long Island, NY

61935
Schurter Inc.
Petaluma, CA

62351
Apple Rubber
Lancaster, NY

62643
United Chemicon
Rosemont, IL

62712
Seiko Instruments
Torrance, CA

62793
Lear Siegler Inc.
Energy Products Div.
Santa Ana, CA

63743
Ward Leonard Electric Co.Inc.
Mount Vernon, NY

64154
Lamb Industries
Portland, OR

64155
Linear Technology
Milpitas, CA

64537
KDI Electronics
Whippany, NJ

64782
Precision Control Mfg. Inc.
Bellevue, WA

64834
West M G Co.
San Francisco, CA

64961
Electronic Hardware LTD
North Hollywood, CA

65092
Sangamo Weston Inc.
Weston Instruments Div.
Newark, NJ

65786
Cypress Semi
San Jose, CA

65940
Rohm Corp & Whatney
Irvine, CA

65964
Evox Inc.
Bannockburn, IL

66150
Entron Inc.
Winslow Teltronics Div.
Glendale, NY

66302
VLSI Technology Inc.
San Jose, CA

66419
Exel
San Jose, CA

66450
Dyna-Tech Electronics, Inc
Walled Lake, MI

66608
Bering Industries
Freemont, CA

66891
BKC International Electronics
Lawrence, MA

66958
SGS Semiconductor Corp.
Phoenix, AZ

66967
Powerex Inc
Auburn, NY

67183
Altera
Santa Clara, CA

68919
WIMA
% Harry Levinson Co.
Seattle, WA

7F361
Richmond-Division of Dixico
% Zellerbach Paper Co.
Seattle, WA

7F844
Moore Business Forms, Inc
Seattle, WA

7G902
Textron Inc.
Camcar Div.
Rockford, IL

7J395
Universal Plastics
Welshpool, WA

7J696
AMD Plastics
East Lake, OH

7K354
Omni Spectra Inc
Los Altos, CA

7Z884
ALPS
Seattle, WA

7X634
Duracell USA
Div. of Dart & Kraft Inc.
Valdese, NC

70290
Almetal Universal Joint Co.
Cleveland, OH

70485
Atlantic India Rubber Works Inc.
Chicago, IL

70563
Amperite Company
Union City, NJ

70903
Cooper-Belden Corp.
Geneva, IL

71002
Bimbach Co. Inc.
Farmingdale, NY

71034
Bliley Electric Co.
Erie, PA

71183
Westinghouse Electric Corp.
Bryant Div.
Bridgeport, CT

71279
Interconnection Products Inc.
Formerly Midland-Ross Cambion Div.
Santa Ana, CA

71400
Bussman Manufacturing
Div. McGraw-Edison Co.
St. Louis, MO

71450
CTS Corp.
Elkhart, IN

71468
ITT Cannon Div. of ITT
Fountain Valley, CA

71482
General Instrument Corp.
Clare Div.
Chicago, IL

71590
Mepco/Centralab
A North American Philips Co.
Fort Dodge, IA

71707
Coto Corp.
Providence, RI

71744
General Instrument Corp.
Lamp Div/Worldwide
Chicago, IL

71785
TRW Inc.
Cinch Connector Div.
Elk Grove Village, IL

71984
Dow Corning Corp.
Midland, MI

72005
AMAX Specialty Metals Corp.
Newark, NJ

72136
Electro Motive Mfg. Corp.
Florence, NC

72228
AMCA International Corp.
Continental Screw Div.
New Bedford, MA

72259
Nytronics Inc.
New York, NY

72619
Amperex Electronic Corp.
Dialight Div.
Brooklyn, NY

72653
G C Electronics Co.
Div. of Hydrometals Inc.
Rockford, IL

72794
Dzus Fastner Co. Inc.
West Islip, NY

72928
Gulton Industries Inc.
Gudeman Div.
Chicago, IL

72962
Elastic Stop Nut
Div. of Harrard Industries
Union, NJ

72982
Erie Specialty Products, Inc
Formerly: Murata Erie
Erie, PA

73138
Beckman Industrial corp.
Helipot Div.
Fullerton, CA

73168
Fenwal Inc.
Ashland, MA

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrance, CA

73445
Amperex Electronic Corp.
Hicksville, NY

73559
Carlingswitch Inc.
Hartford, CT

73586
Circle F Industries
Trenton, NJ

73734
Federal Screw Products Inc.
Chicago, IL

73743
Fischer Special Mfg. Co.
Cold Spring, KY

73893
Microdot
Mt. Clemens, MS

73899
JFD Electronic Components
Div. of Murata Erie
Oceanside, NY

73905
FL Industries Inc.
San Jose, CA

73949
Guardian Electric Mfg. Co.
Chicago, IL

74199
Quam Nichols Co.
Chicago, IL

74217
Radio Switch Co.
Marlboro, NJ

74306
Piezo Crystal Co.
Div. of PPA Industries Inc.
Carlisle, PA

74445
Holo-Krome Co.
Elmwood, CT

74542
Hoyt Elect.Instr. Works Inc.
Penacook, NH

74840
IL Capacitor Inc.
Lincolnwood, IL

74970
Johnson EF Co.
Waseca, MN

75042
TRW Inc.
IRC Fixed Resistors
Philadelphia, PA

75297
Kester Solder Div.
Litton Systems, Inc
Des Plaines, IL

75376
Kurz-Kasch Inc.
Dayton, OH

75378
CTS Knights Inc.
Sandwich, IL

75382
Kulka Electric Corp.
(Now 83330)
Mount Vernon, NY

75569
Performance Semiconductor Corp.
Sunnyvale, CA

75915
Littelfuse Tracor
(Formerly: Tracor-Littelfuse)
Des Plaines, IL

76854
Oak Switch Systems Inc.
Crystal Lake, IL

77122
TRW Assemblies & Fasteners Group
Fastener Div.
Moutainside, NJ

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, IN

77542
Ray-O-Vac Corp
Madison, WI

77638
General Instrument Corp.
Rectifier Div.
Brooklyn, NY

77900
Shakeproof Lock Washer Co.
(Now 78189)

77969
Rubbercraft Corp. of CA Ltd.
Torrance, CA

78189
IL Tool Works Inc.
Shakeproof Div.
Elgin, IL

78277
Sigma Instruments Inc.
South Braintree, MA

78290
Struthers Dunn Inc.
Pitman, NJ

78553
Eaton Corp.
Engineered Fastener Div.
Cleveland, OH

Federal Supply Codes for Manufacturers (cont)

78592
Stoeger Industries
South Hackensack, NJ

79497
Western Rubber Co.
Goshen, IN

79727
C - W Industries
Southampton, PA

79963
Zierick Mfg. Corp.
Mount Kisco, NY

8C798
Ken-Tronics, Inc.
Milan, IL

8D528
Baumgartens
Atlanta, GA

8F330
Eaton Corp.
Cutler Hammer Product Sales Office
Mountain View, CA

8T100
Tellabs Inc.
Naperville, IL

80009
Tektronix
Beaverton, OR

80031
Mepco/Electra Inc.
Morristown, NJ

80032
Ford Aerospace &
Communications Corp.
Western Development
Laboratories Div.
Palo Alto, CA

80145
LFE Corp.
Process Control Div.
Clinton, OH

80183
Sprague Products
(Now 56289)

80294
Bourns Instruments Inc.
Riverside, CA

80583
Hammerlund Mfg. Co. Inc.
Paramus, NJ

80640
Computer Products Inc.
Stevens-Arnold Div.
South Boston, MA

81073
Grayhill Inc.
La Grange, IL

81312
Litton Systems Inc.
Winchester Electronics Div.
Watertown, CT

81439
Therm-O-Disc Inc.
Mansfield, OH

81483
International Rectifier Corp.
Los Angeles, CA

81590
Korry Electronics Inc.
Seattle, WA

81741
Chicago Lock Co.
Chicago, IL

82227
Airpax Corp.
Cheshire Div.
Cheshire, CT

82240
Simmons Fastner Corp.
Albany, NY

82305
Palmer Electronics Corp.
South Gate, CA

82389
Switchcraft Inc.
Sub of Raytheon Co.
Chicago, IL

82415
Airpax Corp
Frederick Div.
Frederick, MD

82872
Roanwell Corp.
New York, NY

82877
Rotron Inc.
Custom Div.
Woodstock, NY

82879
IIT
Royal Electric Div.
Pawtucket, RI

83003
Varo Inc.
Garland, TX

83014
Hartwell Corp.
Placentia, CA

83055
Signalite Fuse Co.
(Now 71744)

83058
TRW Assemblies & Fasteners Group
Fasteners Div.
Cambridge, MA

83259
Parker-Hannifin Corp.
O-Seal Div.
Culver City, CA

83298
Bendix Corp.
Electric & Fluid Power Div.
Eatonville, NJ

83315
Hubbell Corp.
Mundelein, IL

83330
Kulka Smith Inc.
A North American Philips Co.
Manasquan, NJ

83478
Rubbercraft Corp. of America
West Haven, CT

83553
Associated Spring Barnes Group
Gardena, CA

83740
Union Carbide Corp.
Battery Products Div.
Danbury, CT

84171
Arco Electronics
Commack, NY

84411
American Shizuki
TRW Capacitors Div.
Ogallala, NE

84613
FIC Corp.
Rockville, MD

84682
Essex Group Inc.
Peabody, MA

84830
Lee Spring Co. Inc
Brooklyn, NY

85367
Bearing Distributing Co.
San Fransisco, CA

85372
Bearing Sales Co.
Los Angeles, CA

85480
W. H. Brady Co.
Industrial Product
Milwaukee, WI

85840
Brady WH Co
Industrial Products Div
Milwaukee, WI

85932
Electro Film Inc.
Valencia, CA

86577
Precision Metal Products Co.
Peabody, MA

86684
Radio Corp. of America
(Now 54590)

86928
Seastrom Mfg. Co. Inc.
Glendale, CA

87034
Illuminated Products Inc.
(Now 76854)

87516
Standard Crystal
KS City, KS

88044
Aeronautical Standards Group
Dept. of Navy & Air Force

88219
GNB Inc.
Industrial Battery Div.
Langhorne, PA

88245
Winchester Electronics
Litton Systems-Useco Div.
Van Nuys, CA

88486
Triangle PWC Inc.
Jewitt City, CT

88690
Essex Group Inc.
Wire Assembly Div.
Dearborn, MI

88786
Atlantic India Rubber Co.
Goshen, IN

88978
Philips (Now Fluke)
Mahwah, NJ

89020
Amerace Corp.
Buchanan Crimptool Products Div.
Union, NJ

89265
Potter-Brumfield
(See 77342)

89462
Waldes Truarc, Inc.
Long Island, NY

89536
John Fluke Mfg. Co., Inc.
Everett, WA

89597
Fredericks Co.
Huntingdon Valley, PA

89709
Bunker Ramo-Eltra Corp.
Amphenol Div.
Broadview, IL

89730
General Electric
Lamp Div.
Newark, NJ

9R216
Data Composition Svc, Inc
Laurel, MD

9S171
Port Plastics
Tukwila, WA

Federal Supply Codes for Manufacturers (cont)

9W423
Amatom
El Mont, CA

90201
Mallory Capacitor Co.
Sub of Emhart Industries Inc.
Indianapolis, IN

90215
Best Stamp & Mfg. Co.
KS City, MO

90303
Duracell Inc.
Technical Sales & Marketing
Bethel, CT

91094
Essex Group Inc.
Suflex/IWP Div.
Newmarket, NH

91247
IL Transformer Co.
Chicago, IL

91293
Johanson Mfg. Co.
Boonton, NJ

91462
Alpha Industries Inc.
Logansport, IN

91502
Associated Machine
Santa Clara, CA

91506
Augat Alcoswitch
N. Andover, MA

91507
Froeliger Machine Tool Co.
Stockton, CA

91637
Dale Electronics Inc.
Columbus, NE

91662
Elco Corp.
A Gulf Western Mfg. Co.
Connector Div.
Huntingdon, PA

91737
ITT Cannon/Gremar
(Now 08718)

91802
Industrial Devices Inc.
Edgewater, NJ

91833
Keystone Electronics Corp.
NY, NY

91836
King's Electronics Co. Inc.
Tuckahoe, NY

91929
Honeywell Inc.
Micro Switch Div.
Freeport, IL

91934
Miller Electric Co.
Woonsocket, RI

91967
National Tel-Tronics
Div. of electro Audio Dynamics Inc
Meadville, PA

91984
Maida Development Co.
Hampton, VA

91985
Norwalk Valve Co.
S. Norwalk, CT

92218
Wakefield Corp., The
Wakefield, ME

92527
VTC Inc.
Bloomington, MN

92607
Tensolite Co.
Div. of Carlisle Corp.
Buchanan, NY

92914
Alpha Wire Corp.
Elizabeth, NJ

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, MA

94144
Raytheon Co.
Microwave & Power Tube Div.
Quincy, MA

94222
Southco Inc.
Concordville, PA

94988
Wagner Electric Corp.
Sub of Mcgraw-Edison Co.
Whippany, NJ

95146
Alco Electronic Products Inc.
Switch Div.
North Andover, MA

95263
Leecraft Mfg. Co.
Long Island City, NY

95275
Vitramon Inc.
Bridgeport, CT

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, OH

95348
Gordo's Corp.
Bloomfield, NJ

95354
Methode Mfg. Corp.
Rolling Meadows, IL

95573
Campion Laboratories Inc.
Detroit, MI

95712
Bendix Corp.
Electrical Comp. Div.
Franklin, IN

95987
Weckesser Co. Inc.
(Now 85480)

96733
SFE Technologies
San Fernando, CA

96853
Gulton Industries Inc.
Measurement & Controls Div.
Manchester, NH

96881
Thomson Industries Inc.
Port WA, NY

97464
Industrial Retainer Ring
Irvington, NJ

97525
EECO Inc.
Santa Ana, CA

97540
Whitehall Electronics Corp.
Master Mobile Mounts Div.
Fort Meyers, FL

97913
Industrial Electronic
Hardware Corp.
NY, NY

97945
Pennwalt Corp.
SS White Industrial Products
Piscataway, NJ

97966
CBS
Electronic Div.
Danvers, MA

98094
Machlett Laboratories Inc.
Santa Barbara. CA

98159
Rubber-Teck Inc.
Gardena, CA

98278
Malco A Microdot Co.
South Pasadena, CA

98291
Sealectro Corp.
BICC Electronics
Trumbill, CT

98372
Royal Industries Inc.
(Now 62793)

98388
Lear Siegler Inc.
Accurate Products Div.
San Deigo, CA

98978
IERC
(International Electronic Research Corp.)
Burbank, CA

99120
Plastic Capacitors Inc.
Chicago, IL

99217
Bell Industries Inc.
Elect. Distributor Div.
Sunnyvale, CA

99378
ATLEE of DE Inc.
N. Andover, MA

99392
Mepco/Electra Inc.
Roxboro Div.
Roxboro, NC

99515
Electron Products Inc.
Div. of American Capacitors
Duarte, CA

99779
Bunker Ramo- Eltra Corp.
Barnes Div.
Lansdown, PA

99800
American Precision Industries
Delevan Div.
East Aurora, NY

99942
Mepco/Centralab
A North American Philips Co.
Milwaukee, WI

U.S. Service Locations

California
Fluke Technical Center
16969 Von Karman Avenue
Suite 100
Irvine, CA 92714
Tel: (714) 863-9031

Fluke Technical Center
46610 Landing Parkway
Fremont, CA 94538
Tel: (415) 651-5112

Colorado
Fluke Technical Center
14180 East Evans Avenue
Aurora, CO 80014
Tel: (303) 695-1171

Florida
Fluke Technical Center
940 N. Fern Creek Avenue
Orlando, FL 32803
Tel: (407) 896-4881

Illinois
Fluke Technical Center
1150 W. Euclid Ave.
Palatine, IL 60067
Tel: (312) 705-0500

Maryland
Fluke Technical Center
5640 Fishers Lane
Rockville, MD 20852
Tel: (301) 770-1576

New Jersey
Fluke Technical Center
East 66 Midland Avenue
Paramus, NJ 07652-0930
Tel: (201) 599-9500

Texas
Fluke Technical Center
1801 Royal Lane, Suite 307
Dallas, TX 75229
Tel: (214) 869-2848

Washington
Fluke Technical Center
John Fluke Mfg. Co., Inc.
1420 75th St. S.W.
M/S 6-30
Everett, WA 98203
Tel: (206) 356-5560

International

Argentina
Coasin S.A.
Virrey del Pino 4071 DPTO E-65
1430 CAP FED
Buenos Aires
Tel: 54 1 522-5248

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23 Lakeside Drive
Tally Ho Technology Park
East Burwood
Victoria 3151

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Scientific & Industrial
25-27 Paul St. North
North Ryde N.S.W. 2113
Tel: 61 02 888 8222

Austria
Oesterreichische Philips Industrie
Unternehmensbereich Prof. Systeme
Triesterstrasse 66
Postfach 217
A-1101 Wein
Tel: 43 222-60101, x1388

Belgium
Philips & MBLE Associated S.A.
Scientific & Industrial Equip. Div
Service Department.
80 Rue des deux Gares B-1070
Brussels
Tel: 32 2 525 6111

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Hi-Tek Electronica Ltda.
Al. Amazonas 422, Alphaville
CEP 06400 Barueri
Sao Paulo
Tel: 55 11 421-5477

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400 Britannia Rd. East, Unit #1
Mississauga
Ontario L4Z 1X9
Tel: 416-890-7600

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Appendix 7A
Manual Status Information

INTRODUCTION

To identify the configuration of the pcb's used in your instrument, refer to the revision leter (marked in ink) on the component side of each pcb assembly. Table 7A-1 defines the assembly revision levels documented in this manual.

NEWER INSTRUMENTS

As changes and improvements are made to the instrument, they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

Table 7A-1. Manual Status and Backdating Information

Ref Or Option No.	Assembly Name	Fluke Part No.	PCB revision level documented in this manual.																					
			—	A	B	C	D	E	F	G	H	J	K	L	M	N	P								
A1	Main PCB Assembly	469312	●	●	●	+	+	+	+	+	+	+	+	+	+	X									
A2	Display PCB Assembly	464297	●	●	●	●	●	X																	
A3	RTD PCB Assembly	469304	●	●	●	+	X																		
-002	Output PCB Assembly	466144	●	○	+	+	+	+	+	+	+	+	+	+	X										
-004	IEEE-488 Interface PCB Assembly	778456	○	+	X																				
-006	Limits PCB Assembly	466185	○	○	○	○	○	X																	

X = The PCB revision levels documented in this manual.
○ = These revision letters were never used in the instrument.
+ = Revision not documented in this manual.
— = No revision letter on the PCB.

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Section 8
Schematic Diagrams

TABLE OF CONTENTS

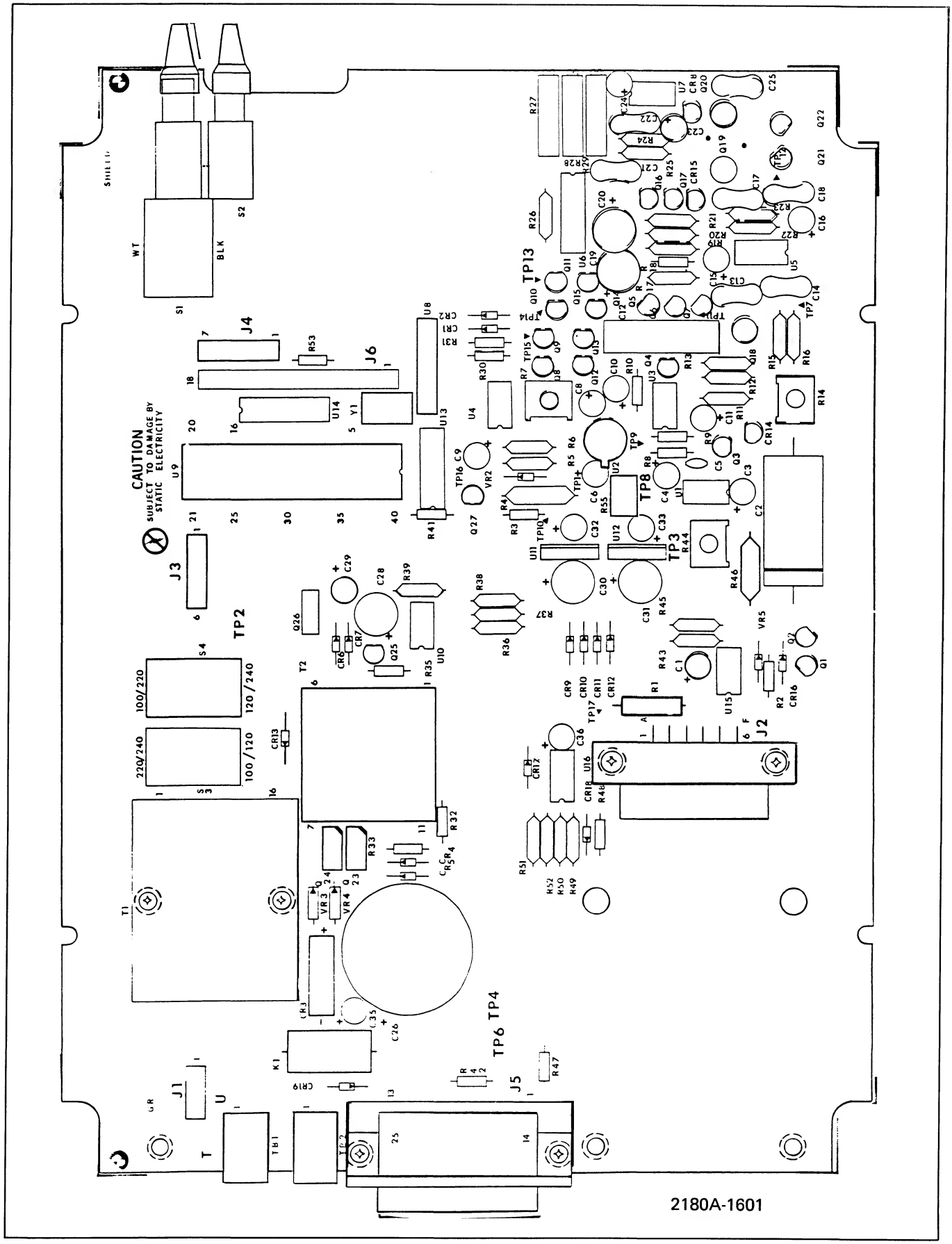
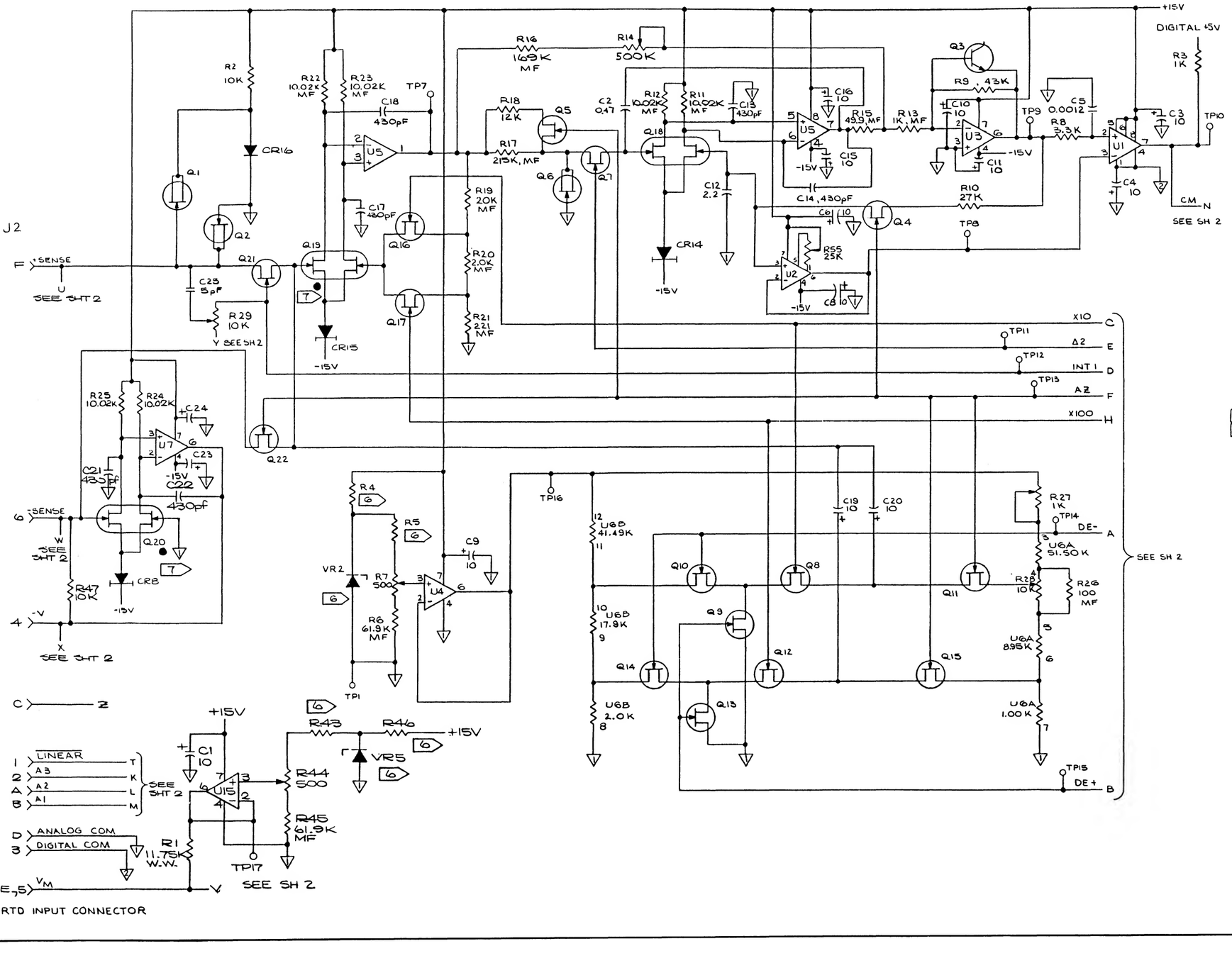


Figure 8-1. A1 Main PCB Assembly



NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTORS ARE 1/4 W, 5% UNLESS OTHERWISE NOTED.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.
4. ▽ DENOTES ANALOG COMMON. (0 VOLTS)
   ▽2 DENOTES LOGIC COMMON. DIGITAL COMMON IS -15V WITH RESPECT TO ANALOG COMMON.
   ⏚ DENOTES EARTH COMMON
   WARNING: DO NOT CONNECT ▽2 TO ▽ DAMAGE MAY RESULT

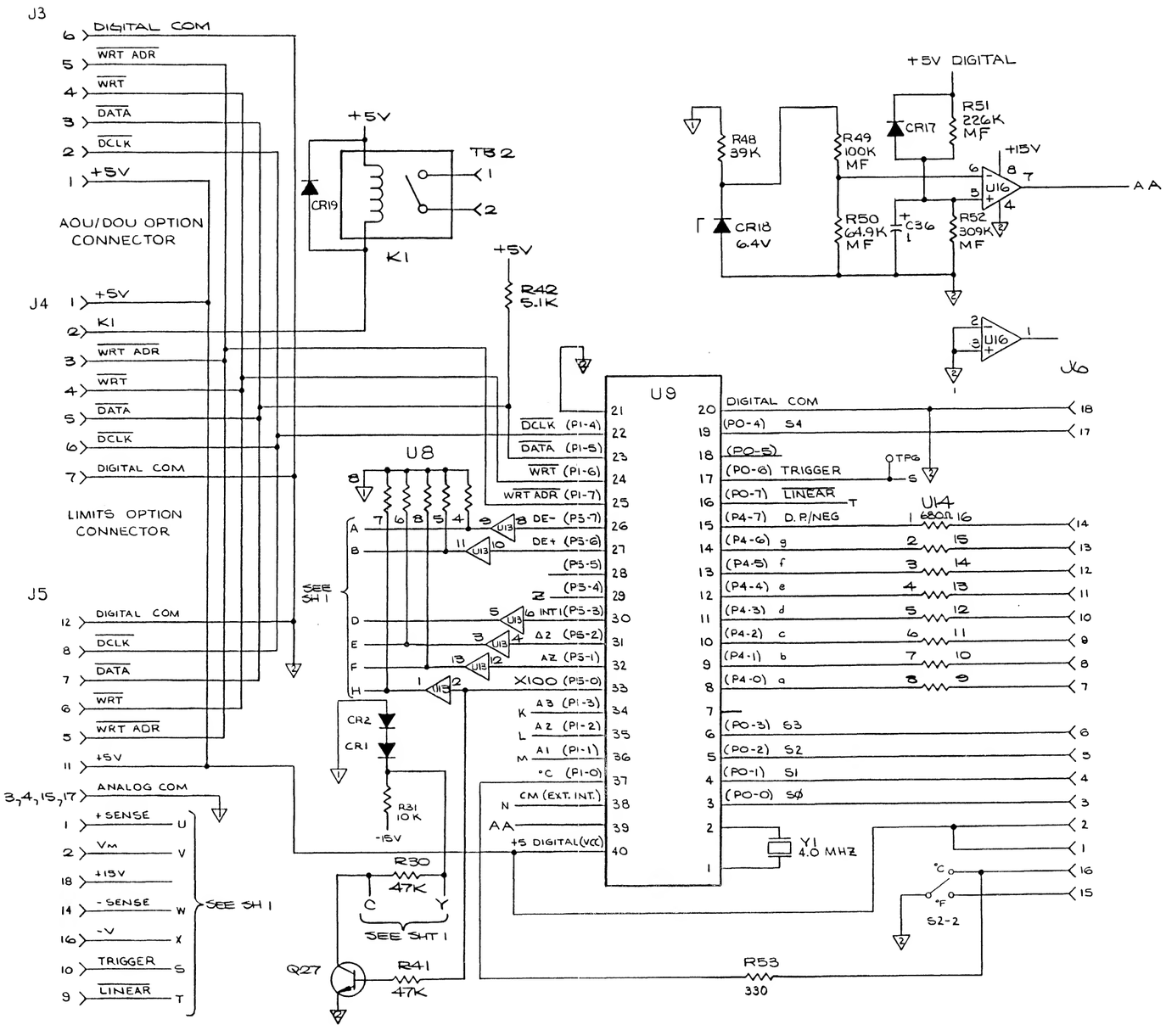
5. SELECTED SET
6. POSITION Q19 & Q20 WITH MARKED GATE IN POSITION SHOWN

REF DES	+5 DIG.	+15V	▽2	▽
U1		5,6,8	1,4	
U2		7	4	
U3		7	4	3
U4		7		4
U5		8	4	
U6				7,8
U7		7	4	
U8				1
U9	40		20	
U10			4	
U13	14		7	
U14				
U15		7		4
U16		8	4,2,3	

REF DES	
LAST USED	NOT USED
CR19, R55, C36, U16, VR5, Q27, T2.	VR1, R54

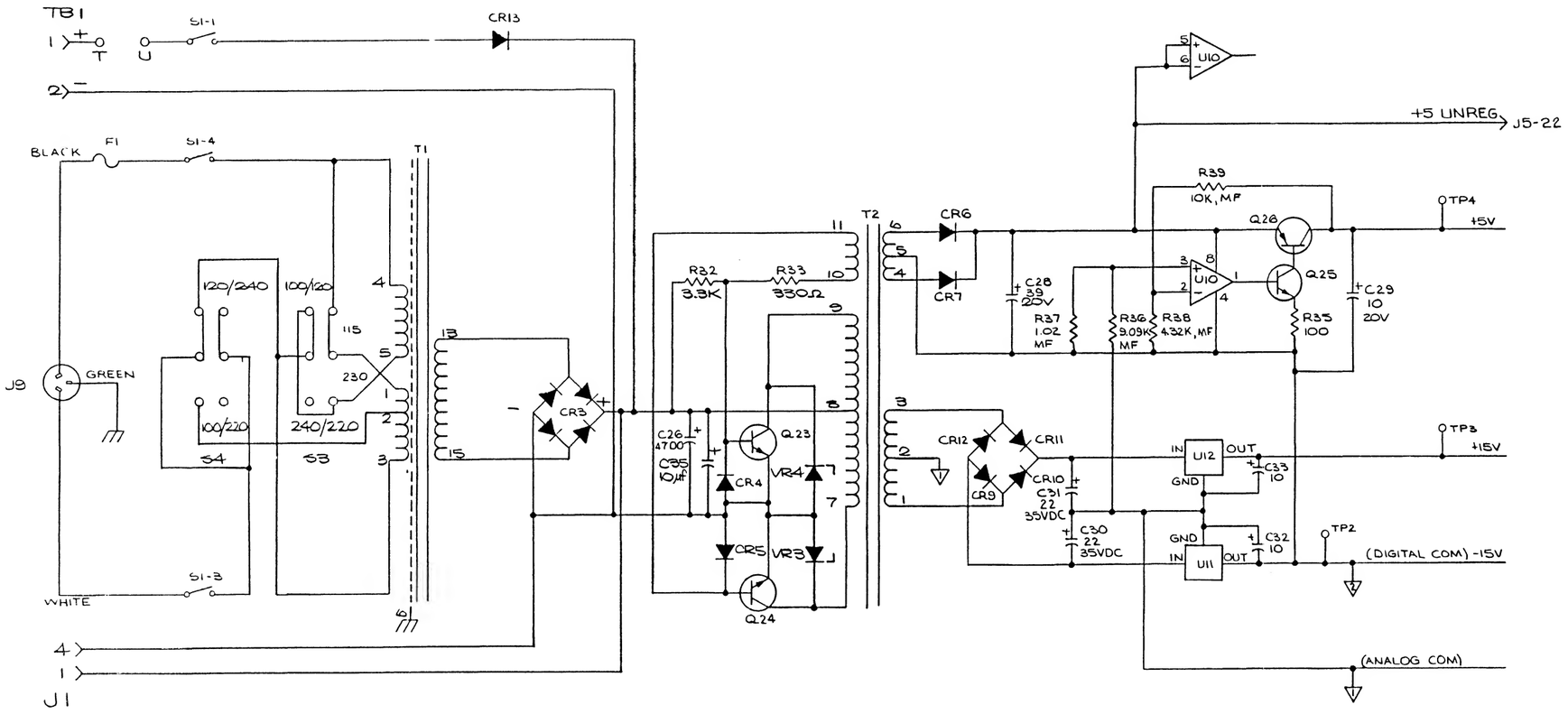
2180A-1001
(Sht 1 of 3)

Figure 8-1. A1 Main PCB Assembly (cont)



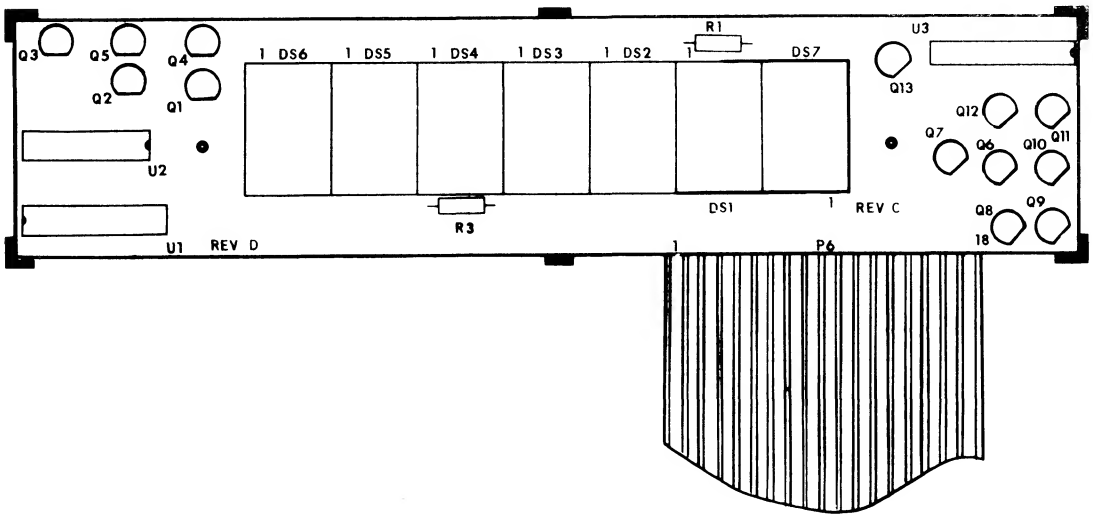
2180A-1001
(Sht 2 of 3)

Figure 8-1. A1 Main PCB Assembly (cont)



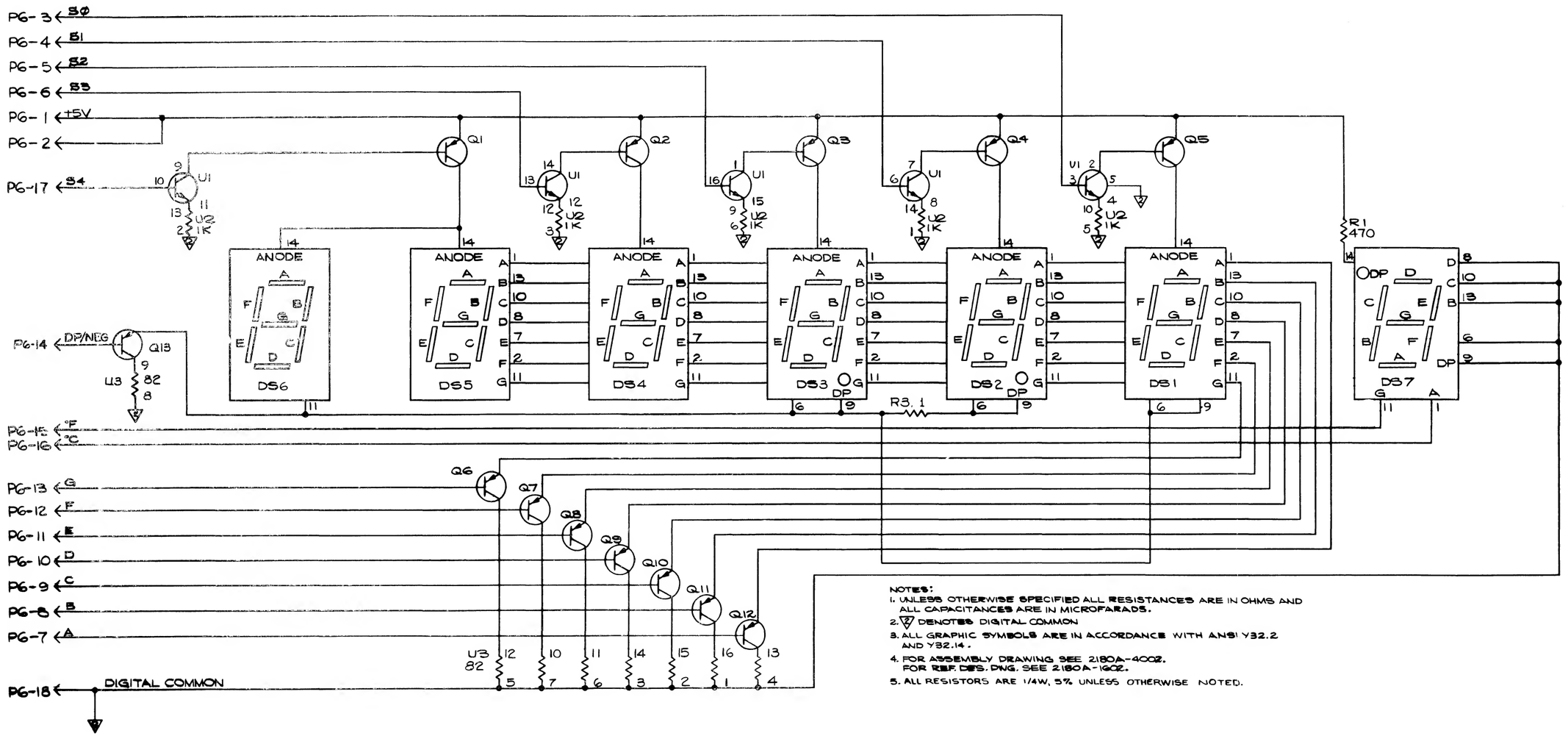
2180A-1001
(Sht 3 of 3)

Figure 8-1. A1 Main PCB Assembly (cont)



2180A-1602

Figure 8-2. A2 Display PCB Assembly



2180A-1002

Figure 8-2. A2 Display PCB Assembly (cont)

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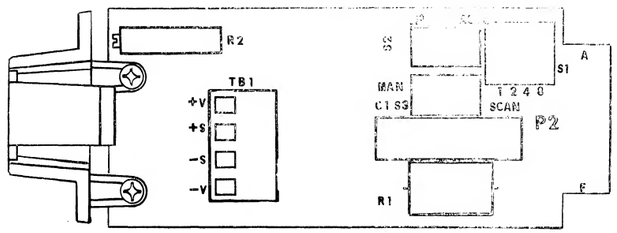
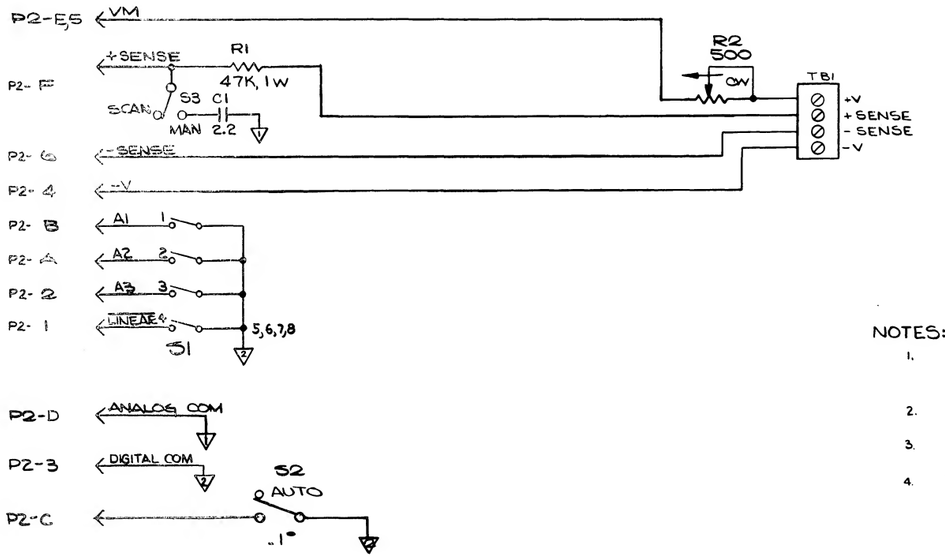


2180A-1603

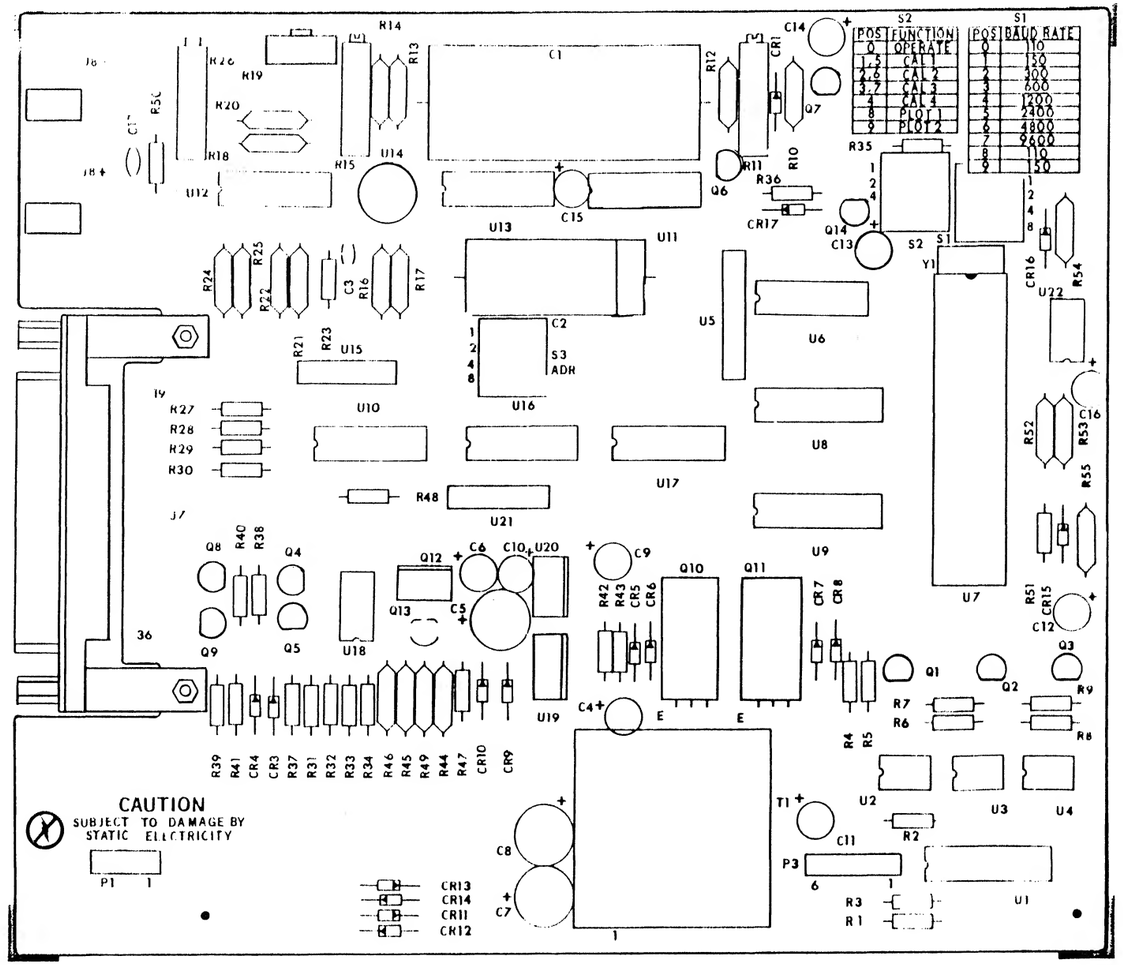


NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTORS ARE ¼W, 5% UNLESS OTHERWISE NOTED.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.
4. ▽ DENOTES ANALOG COMMON. ▽ DENOTES DIGITAL COMMON.

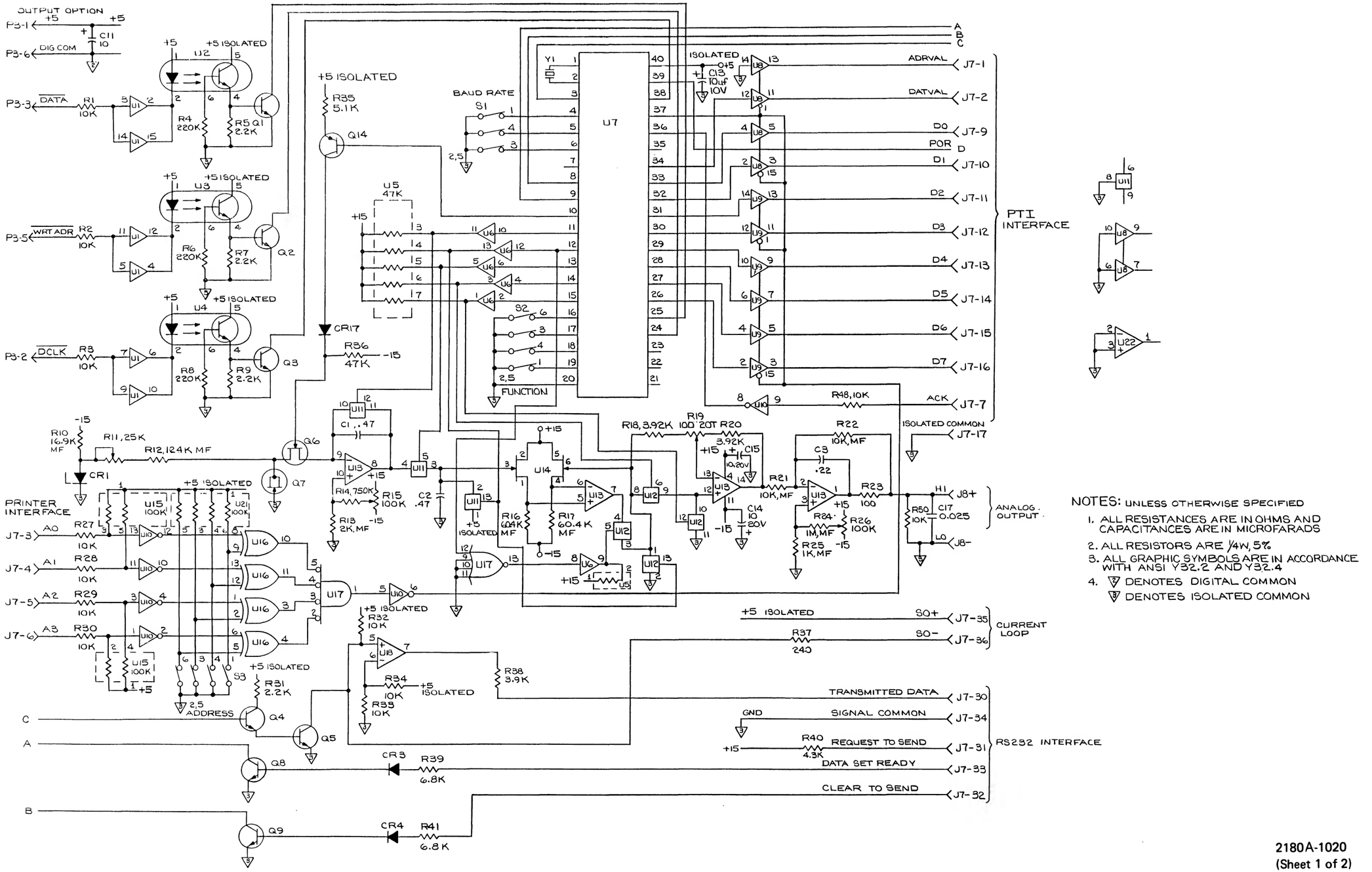
2180A-1003

Figure 8-3. A3 RTD Input PCB Assembly



2180A–1620

Figure 8-4. Option –002 Output PCB Assembly

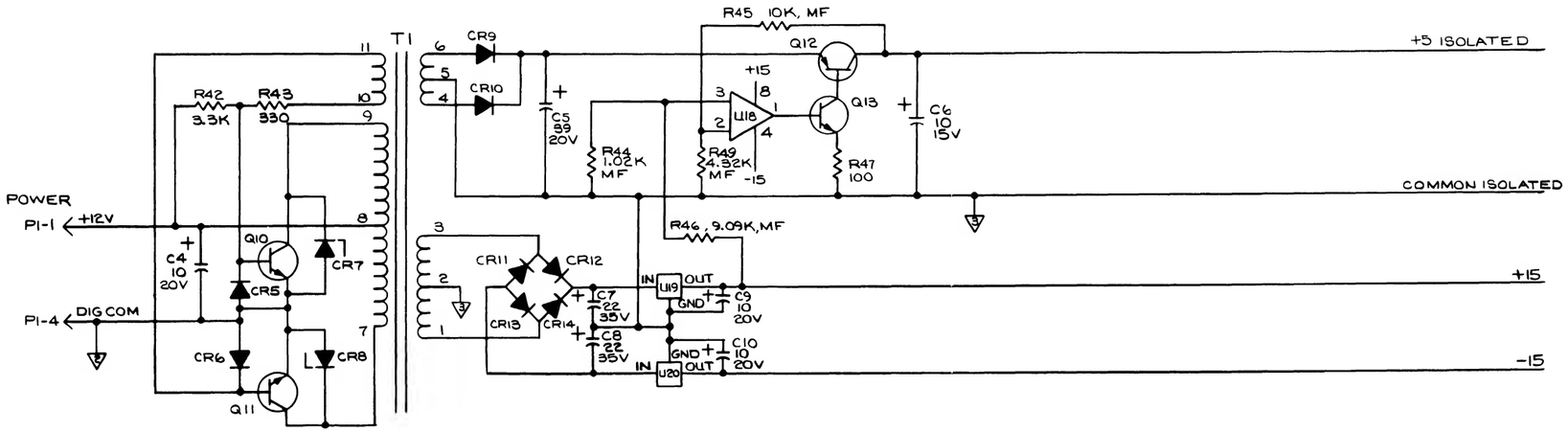


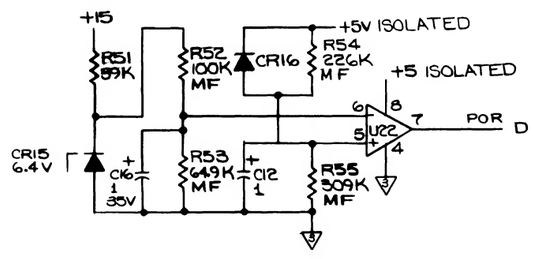
NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTANCES ARE IN OHMS AND CAPACITANCES ARE IN MICROFARADS
2. ALL RESISTORS ARE 1/4W, 5%
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.4
4. ▽ DENOTES DIGITAL COMMON
   ▽ DENOTES ISOLATED COMMON

2180A-1020
(Sheet 1 of 2)

Figure 8-4. Option –002 Output PCB Assembly (cont)





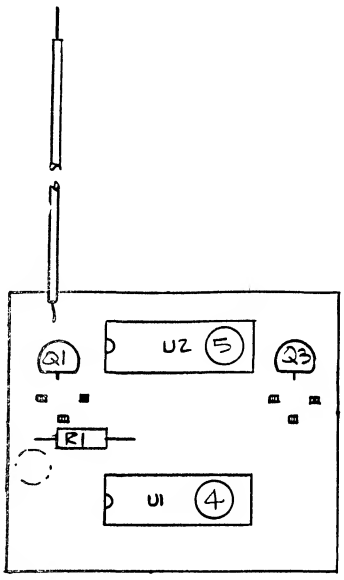
REF DESIGNATIONS	
LAST USED	NOT USED
C17	
CR17	CR2
U22	
R55	
Q14	
S3	
T1	

DES	+5	GND	+5 ISOLATED	+15	-15	GND ISOLATED
U1	1	8				
U2	1		5			
U3	1		5			
U4	1		5			
U5				1		
U6			14			7
U7			40			20
U8			16			8
U9			16			8
U10			14			7
U11				14		7
U12				14		7
U13				4	11	
U14				2.5/6		
U15, U21			1			
U16			14			7
U17			14			7
U18				8	4	

DES	+5	GND	+5 ISOLATED	+15	-15	GND ISOLATED
U22		4	8			

2180A–1020
(Sheet 2 of 2)

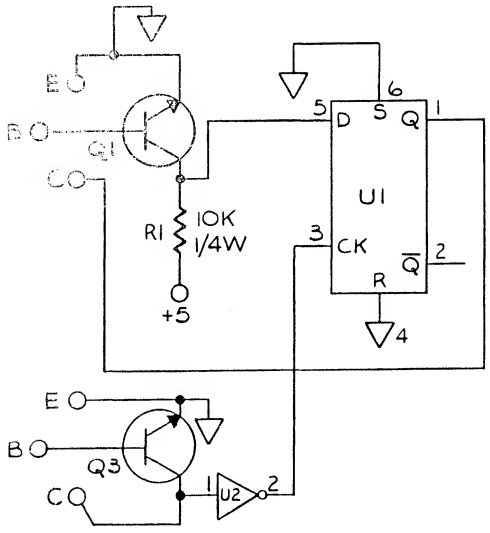
Figure 8-4. Option –002 Output PCB Assembly (cont)



WARNING: ⊗ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 15.7.

CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

2180A-1621



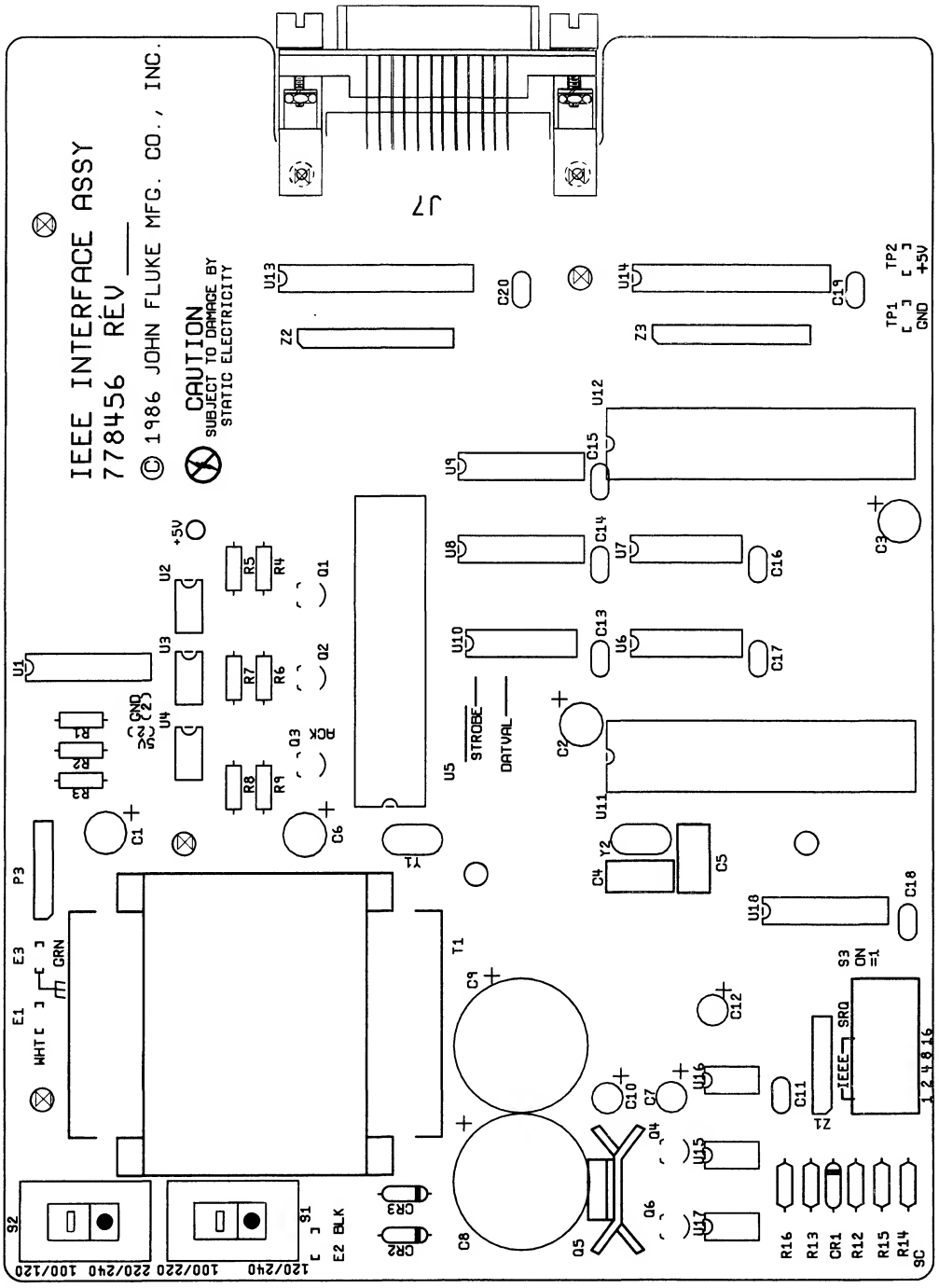
NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL RESISTANCES ARE IN OHMS.
2. ALL CAPACITANCE ARE IN MICROFARADS.
3. ALL RESISTORS ARE 1/4W, 5%.

IC	+5	GND
U1	14	7,8,9,10,11
U2	14	3,5,7,9,11,13

2180A-1021

Figure 8-4A. Output Unit Adapter PCB Assembly



WARNING: Ⓝ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1

2180A-1601

Figure 8-5. Option -004 IEEE-488 Interface PCB Assembly

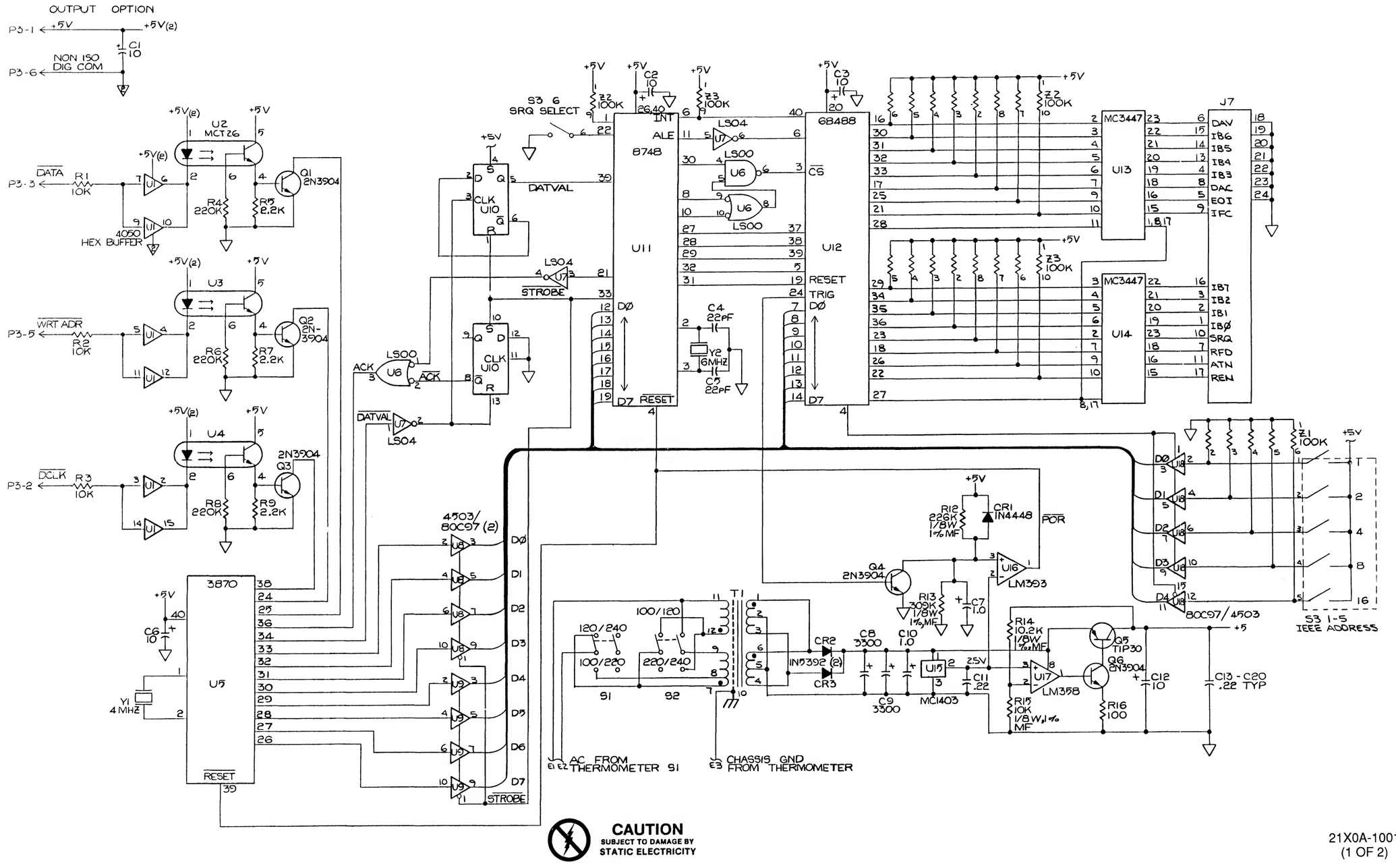


Figure 8-5. Option -004 IEEE-488 Interface PCB Assembly

NOTES : UNLESS OTHERWISE SPECIFIED .

1. ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTANCES ARE IN OHMS.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.
4. ALL RESISTORS ARE 1/4 W 5% CARBON FILM.
5. ▽ DENOTES DIGITAL COMMON ISO.
6. ▽ DENOTES DIGITAL COMMON NON-ISO.

[7] PINS 3,5,7,8,9,10,11,12,13,14,15,16,17,18,19,21,22,23,35.

8. **WARNING:** ⊗ INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 19.1

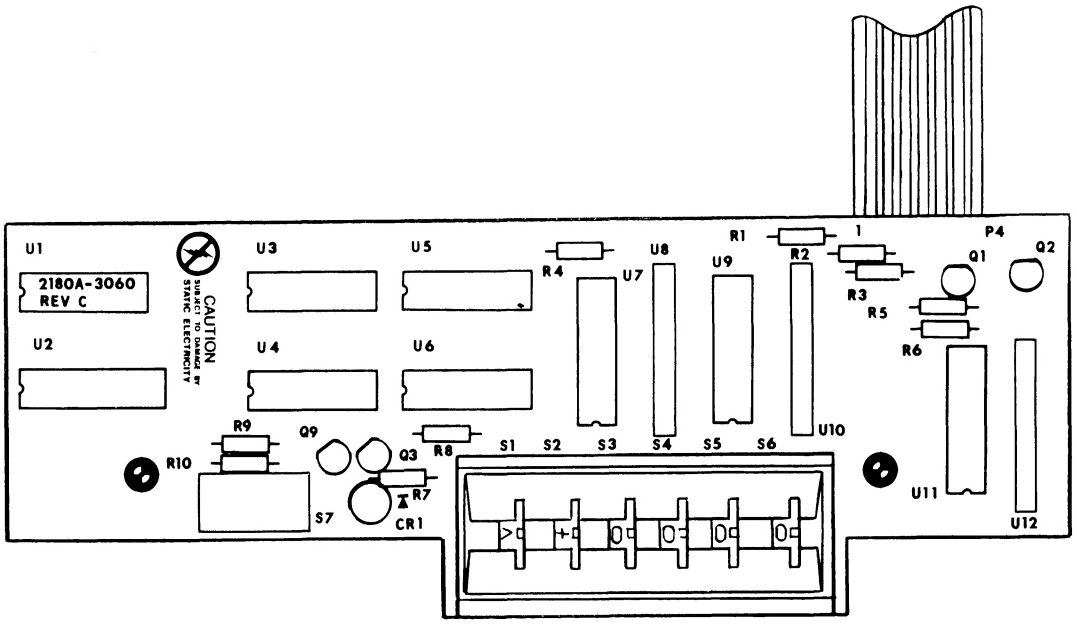
LAST USED	NOT USED
U18	
R16	
C20	
Q6	
CR3	
Y2	
T1	
Z3	
S3	S3 7,8

REF DES	+5(2)	▽8	+5	▽	NO CONNECTION
U1	1	8			13,16
U2	1		5		3
U3	1		5		3
U4	1		5		3
U5			40	4,6,20,37	[7]
U6			14	7,12,13	11
U7			14	7,9,11,13	8,12,10
U8			15,16	8,12,14	11,13
U9			15,16	8,12,14	11,13
U10			4,14	7,11,12	9
U11			26,40	7,20,23,35,36	9,5,25,34,37,38
U12			20	1,2	19
U13			24	12,13,14	
U14			1,24	11,12,13,14	
U15			—	3	4,5,6,7,8
U16			8	4	5,6,7
U17			8	4	5,6,7
U18			14,16	8	13
J7					12
S3					8

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY

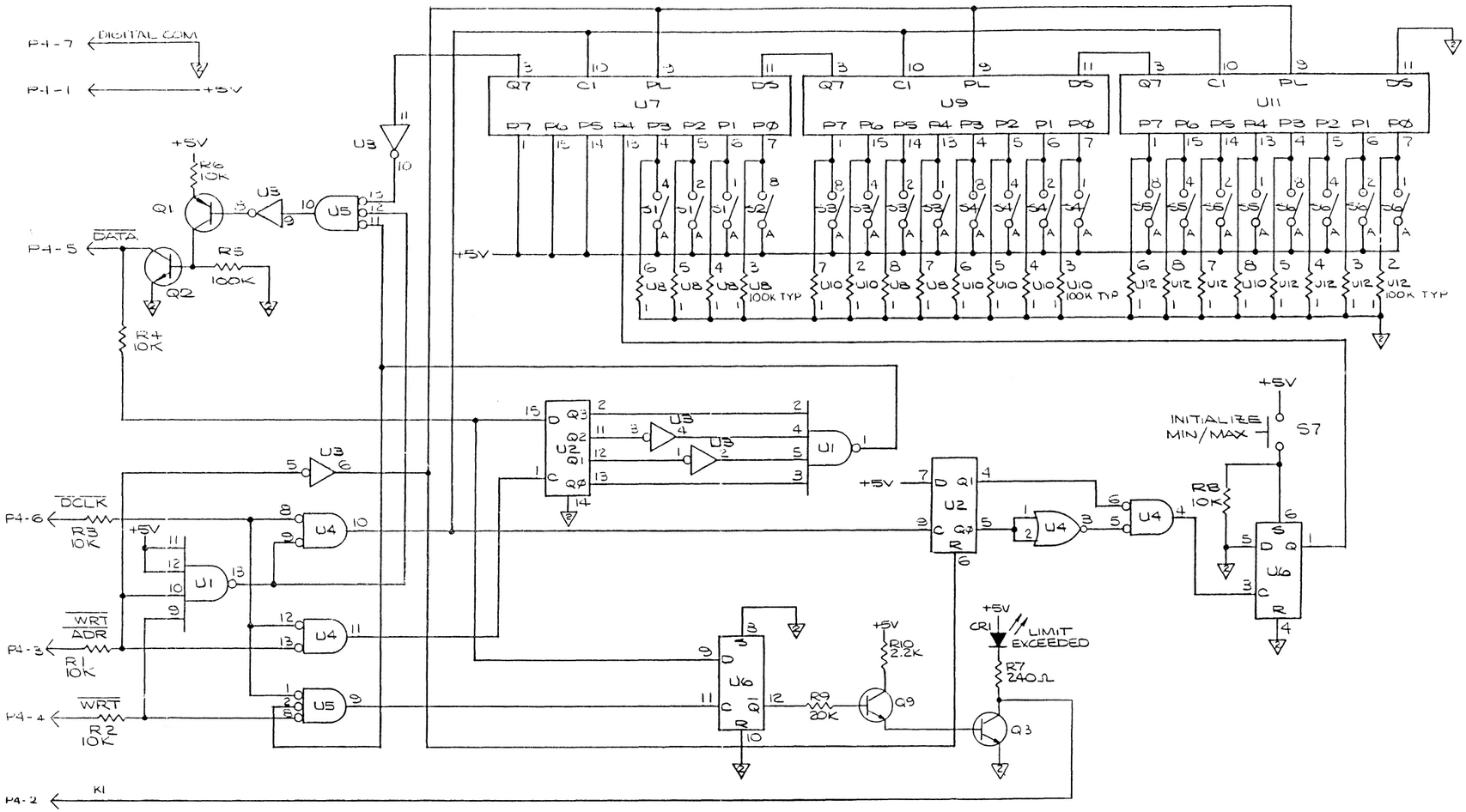
21X0A-1001
(2 OF 2)

Figure 8-5. Option -004 IEEE-488 Interface PCB Assembly (cont)



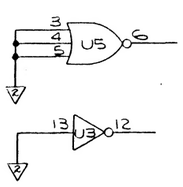
2180A-1660

Figure 8-6. Option -006 Limits PCB Assembly



NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTORS ARE 1/4W, 5% UNLESS OTHERWISE NOTED.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 & Y32.14.
4. ▽ DENOTES DIGITAL COMMON. DIGITAL COMMON IS -15V WITH RESPECT TO ANALOG COMMON



I.C.	+5V	▽
U1	14	7
U2	16	8
U3	14	7
U4	14	7
U5	14	7
U6	14	7
U7	16	8
U9	16	8
U11	16	8

REF DES	
LAST USED	NOT USED
U12, R8, S7, Q9	Q4, Q5, Q6, Q7, Q8

2180A-1060

Figure 8-6. Option -006 Limits PCB Assembly (cont)

ANALOG COM	Measurement common
AZ	Auto-Zero
CM	Compare input to the microcomputer
$\overline{\text{DATA}}$	Data on bus
$\overline{\text{DCLK}}$	Data clock
DE+	Read a plus input
DE–	Read a minus input
DIGITAL COM	–15V with respect to Analog Com
D.P./NEG	Drives decimal point, depending on reading and resolution
INT 1	Causes the unknown voltage to be integrated
$\overline{\text{LINEAR}}$	Used to command the microcomputer to display linear counts
$\overline{\text{WRT}}$	Write
$\overline{\text{WRT ADR}}$	Write address, signals that an address is being transmitted
X10	Selects a buffer gain of X10 (0.1° resolution)
X100	Selects a buffer gain of X100 (0.01° resolution)
Δ2	Hold command
+SENSE	Voltage sense wires from RTD – no current flows in these wires
–SENSE	Voltage sense wires from RTD – no current flows in these wires
+Vm	An intermediate voltage – not used directly
–V	Current return

Figure 8-7. Mnemonics